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NUCLEAR SCIENCE ABSTRACTS

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NUCLEAR SCIENCE ABSTRACTS

GENERAL AND MISCELLANEOUS

32624 (KR-24) VISIT OF A NORWEGIAN ATOMIC ENERGY DELEGATION TO THE U.S.S.R., JANUARY 1962. E. Andersen, K. P. Lien, T. Riste, and S. Aas (Norway. Institutt for Atomenergi, Kjeller). May 1962. 37p.

The visit of a four man delegation from Institutt for Atomenergi, Kjeller, Norway to atomic energy installations in the U.S.S.R. is described. The visit took place under the program on cultural exchange between the U.S.S.R. and Norway. During a ten day period the following six research institutions were visited: Joint Institute for Nuclear Research, Dubna; Institute of Theoretical and Experimental Physics (Alikhanov Institute), Moscow; Voronezh Atomic Power Plant, Novovoronezh; Central Scientific Research Institute of Ferrous Metallurgy, Moscow; Physical and Energetical Institute, Obninsk; and Institute of Atomic Energy (Kurchatov Institute), Moscow. Publications are referred to where further information may be obtained. (auth)

32625 (NYO-9888) LIMITING FACTORS IN THE RAPID IDENTIFICATION OF SELECTED MATERIALS BY NUCLEAR TECHNIQUES. Annual Progress Report, May 1960–July 1961. Edward D. Jordan (Catholic Univ. of American, Washington, D. C.). Aug. 1961. Contract AT(30-1)-2586. 132p. (CUA-NE-16)

Sabotage of commercial passenger aircraft by detonation of explosives in passenger luggage has become a problem of major concern. The technical and economic aspects of certain schemes for luggage surveillance by nuclear engineering techniques were investigated. The possibility of incorporating a small amount of non-radioactive additive material to commercial explosives is given major consideration. The potential explosive container, luggage, is exposed to a low level thermal neutron flux field. With a 0.5% B additive concentration in a one half pound explosive test cartridge, the optimum signal to background ratio varies from 1.35 to 1.50, depending upon explosive location in a 25 cm test channel. This data represents the response obtained for a single explosive cartridge in a fully packed suitcase with a four curie Pu–Be neutron source and a scanning time of 6 sec. Economic aspects of the system can be markedly affected by many intangible factors. Other measurements were undertaken for various additive material approaches to the problem. (auth)

32626 (AEC-tr-5406) A MESSAGE FROM THE EARTH: — EXPLOSION! A. Golikov and G. Koposov. Translated from Ogoněk, No. 22, 30-2(1962). 10p.

A discussion of principles involved in detecting nuclear explosions is presented in layman's language. Political comment concerning the western reluctance to accept Soviet nuclear disarmament proposals is included. (J.R.D.)

32627 NONMILITARY CBR DEFENSE. John W. Walsh (U. S. Public Health Service, Washington, D. C.). Ariz. Med., 19: 56-60(Mar. 1962).

The effects of chemical-biological-radiological (CBR) warfare on exposed populations and possible defensive measures are discussed. Estimates are made of total casualties and the percentage of casualty types (blast, burn, radiation) from thermonuclear weapons of various size. Radiation doses permissible to civil defense personnel during life-saving operations are discussed; as an upper limit, it is suggested that the cumulative dose over a 7-day period may be 33 r for routine operations, 66 r for operations with a calculated risk, and 96 r for command decision operations. The latter operations would thus entail a 6-week mortality rate of 0.5% or less. Construction of fallout-protected hospitals is discussed, as well as the high demand for antibiotics for radiation-injured patients following thermonuclear warfare, which might overtax the national supply. (H.H.D.)

32628 NOMOGRAM FOR THE UTILIZATION OF RADIOISOTOPES. R. Stiennon-Bovy and G. Geladi (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Intern. J. Appl. Radiation and Isotopes, 12: 64-5(1961). (BLG-80). (In French)

This nomogram enables the determination of the activity A of a radioelement with a half life T (days) which is needed when an activity a is taken every r days during n days. This nomogram is simplified when T has a determined value. Nomograms are given for various isotopes which are frequently used for medical applications, e.g., gold-198, iodine-131, and phosphorus-32. (auth)

32629 DETECTION OF NUCLEAR EXPLOSIONS IN SPACE AND UNDERGROUND. I. Maddock (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). J. Brit. Inst. Radio Engrs., 23: 415-27(June 1962).

Nuclear explosions in space may be detected by the emission of electromagnetic and particle radiation. Detection instruments may be carried in satellites. The capabilities of the various techniques are reviewed. Seismic methods for the detection of underground explosions are discussed. Signal/noise ratio problems predominate and a seismometer array is described which provides discrimination against waves from different sources. (auth)

32630 CONTAMINATION AND DECONTAMINATION. H.-W. Jensen (Staatliche Schiffsingenieurschule, Flensburg, Ger.). Kerntechnik, 4: 369-71(Sept. 1962). (In German)

The ideas of contamination and decontamination are ex-

plained and the most important methods for decontamination described. The problems of storage and removal of radioactive waste are outlined. (auth)

32631 REMOVAL OF RADIOACTIVE FISSION PRODUCTS DURING THE PREPARATION OF DRINKING WATER BY FLOCCULATION. Klaus Haberer (Technische Hochschule, Karlsruhe, Ger.). Kerntechnik, 4: 377-82(Sept. 1962). (In German)

The decontamination effect of surface water preparation plants is of great importance in the drinking water supply due to the danger from increasing radioactive fallout. Results are reported of measurements for the determination of the decontamination degree which had been taken at seven German drinking water barrages since October 1958. They also contain the results of measurements taken during the period since the resumption of nuclear tests through June 1962. The efficiency of flocculation for the elimination of radioactive matter was investigated gamma-spectrometrically in special tests during the preparation at the Eckertal dam. A comparison of the radioactivity concentrations taken from the crude water with the specific activities measured at the filter silt showed good agreement. Thus, it is possible to determine the course of activity of barrage crude water by way of filter silt measurements. A comparison of the results of these measurements with the activities passing into the ground by precipitations shows that the precipitation activities of the past winter and spring entered the preparation plants of the barrage after a very short time. (auth)

32632 DEGREES OF DECONTAMINATION AND CAPACITY OF A WATER PREPARATION INSTALLATION OF THE KRUPP TYPE. A. Sittkus. Kerntechnik, 4: 383-6 (Sept. 1962). (In German)

An installation, developed by Krupp, for the purification of surface water with ionically dissolved radioactive contamination was tested in practice in a comprehensive test. The degrees of restraint as a function of the quantity processed, and the restraint capacity of the individual parts of the installation were established for the isotopes I^{131}, Ce^{144}, Cs^{137}, Sc^{46}, Co^{60}, and Sr^{90}. Furthermore, the quantities of isotopes built into the individual filters were calculated. (auth)

32633 NUKLEARNA ENERGIJA U JUGOSLAVIJI. (Nuclear Energy in Yugoslavia). Slobodan Nakićenović, ed. Beograd, Export Press, 1961.

The development of nuclear energy in Yugoslavia is reported. Discussion is given on economic conditions in the country; the Boris Kidrič Inst. at Vinča; the Jožef Stefan Inst., the Rudjer Bošković Inst. in Zagreb; present status in the field of basic research; early stages of the nuclear power program; development of isotope applications in agriculture, medicine, and industry; nuclear raw materials survey; Inst. for the Technology of Mineral Raw Materials; protection against ionizing radiations; electronics and instrumentation; cooperation with universities; training; scientific meetings in Yugoslavia; cooperation in the international sphere; federal administrative organs in the field of nuclear energy; Nuclear Energy Commission Program for 1961; prospective development; and scientific and technical staff. Nuclear energy legislation and lists of publications resulting from work in Yugoslavia are also given. (OID)

32634 PHYSICAL SCIENCES. SOME RECENT ADVANCES IN FRANCE AND THE UNITED STATES. PROCEEDINGS OF THE SYMPOSIUM ON BASIC SCIENCE IN FRANCE AND THE UNITED STATES. Hartmut P. Kallmann, Serge A. Korff, and Sidney G. Roth, eds. New York, New York University Press, 1962. 250p. $7.50

Papers presented at the Symposium on Basic Science in France and the United States are given. The 19 papers are arranged under the following headings: science, research, and education; radioastronomy; solid-state physics and magnetic resonance; geology; and hydraulics. Separate abstracts were prepared for 2 papers. (M.C.G.)

32635 THE MAGNETISM OF SOME RARE-EARTH COMPOUNDS. John H. Van Vleck. p.113-28 of "Physical Sciences." New York, New York University Press, 1962.

The application of quantum mechanical theory to the magnetism of various rare-earth compounds is reviewed. The theory of free ions, crystalline fields, dipolar interaction, exchange coupling, and the magnetism of the rare-earth metals are discussed. (M.C.G.)

32636 RESEARCH ON THERMAL CYCLES AND THE DIRECTIONAL ORDER OF DEFECTS. Louis Néel. p.142-55 of "Physical Sciences." New York, New York University Press, 1962.

Results obtained in the field of magnetism on thermal cycles and the application of the phenomena connected with directional order to the study of defects created by irradiation in ferrimagnetic solids are presented. The variation in magnetization produced, at constant magnetic field, by variation in temperature between two given limits was determined. The thermal cycles produced 3 different effects: a large irreversible increase in magnetization, whether the temperature is raised or lowered; a relatively weak reversible variation in magnetization; and a progressive increase in magnetization with the number of cycles constituting a thermal reptation. The effects of heating or cooling under a magnetic field were found to be identical. The magnetic aftereffect associated with directional order created by point defects was studied for ferrimagnetic solids. (M.C.G.)

BIOLOGY AND MEDICINE

General and Miscellaneous

32637 (HW-SA-2731) SOME COMMENTS ON THE ANALYSIS OF THE VARIABILITY IN BLOOD CONSTITUENTS. Carl A. Bennett (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 20, 1962. Contract AT(45-1)-1350. 10p.

A discussion is presented concerning the effects of computers on statistical analysis. One aspect that is examined concerns the relative ease with which it is possible to handle non-orthogonal situations, and the consequent tendency toward retrospective analysis. The other aspect considered concerns the ability to quickly and easily perform multiple tests and re-tests on the same set of data, and the consequent confusion which this engenders in regard to significant levels and the ability to distinguish indications from conclusions. A specific example of computer data analysis is presented in which the starting information was on human hemoglobin analysis, packed cell volume, and leucocyte history. (J.R.D.)

32638 (ORO-583) SEMI-ANNUAL PROGRESS REPORT, JULY 1–DECEMBER 31, 1961. (Tennessee. Univ., Oak Ridge. UT-AEC Agricultural Research Lab.). Contract AT(40-1)-Gen-242. 81p. (UT-ARL-1)

Research progress is reported on physiological and clinical effects of radiation, physiology of reproduction, radiation pathology, fission product metabolism in animals and poultry, fission product chemistry of soils, biochemistry of fission product elements, and plant genetics. (M.C.G.)

32639 (TID-16459) SEMIANNUAL PROGRESS REPORT [ON RADIOBIOLOGY]. (Utah. Univ., Salt Lake City. Radiobiology Lab.). Sept. 30, 1956. Contract AT(11-1)-119. 62p.

Data are summarized from long-term studies on the toxic effects of radioisotopes in dogs. Biological effects and radiological findings are summarized. Results are included from measurements of the plasma concentration and excretion of Pu^{239} made 3.5 years after injection, studies of Pu retention in rats, and tracer studies on the metabolism of Sr^{85} in humans. (C.H.)

32640 (TID-16970) PRODUCTION AND STUDY OF ASPOROGENIC MUTANTS OF BACILLUS CEREUS. Annual Report, June 1, 1962–December 31, 1962. Donald G. Lundgren (Syracuse Univ., N. Y.). Contract AT(30-1)-2038. 37p.

Progress is reported in studies on the production of asporogenic bacterial mutants and the subsequent application of these mutants in studies on the biochemical and physiological aspects of the sporulation process. Data are presented on the distribution of Fe^{59} in the different chemical fractions of normal Bacillus cereus and an asporogenic mutant. The levels of cystine and cysteine were compared in a normal and an auxotrophic mutant of B. cereus. Reaction mechanisms in metabolism are discussed. (C.H.)

32641 (UCRL-10211) BIOLOGY AND MEDICINE SEMIANNUAL REPORT, SPRING 1962. John H. Lawrence, ed. (California. Univ., Berkeley. Lawrence Radiation Lab.). June 1962. Contract W-7405-eng-48. 198p.

Separate abstracts were prepared for 16 sections of this report. Abstracts on two sections have previously appeared in NSA. (C.H.)

32642 (UCRL-10211(p.1-8)) KINETICS OF THE ALKALINE DENATURATION OF HEMOGLOBIN IN THE SINGLE ERYTHROCYTE. B. Thorell and G. Matioli (California. Univ., Berkeley. Lawrence Radiation Lab.).

Microspectrophotometric recording procedures are described that were applied to the analysis of the alkali denaturation kinetics of the hemoglobin (Hb) within single erythrocytes of normal human adult, human fetal, and chicken blood. The relative concentrations of the alkali-resistant Hb-F was 72% in the fetal blood samples and about 30% in chicken blood samples. No Hb-F was detectable in normal human adult blood samples. Results also indicate that the relative concentrations of Hb-A and Hb-F in a single cell can differ over a rather wide range. (C.H.)

32643 (UCRL-10211(p.9-15)) INFECTIOUS MACROMOLECULES. John H. Northrop (California. Univ., Berkeley. Lawrence Radiation Lab.).

Results are reviewed from a number of studies on the nature of viruses. It is pointed out that recent results indicate that many, if not all, viruses are infectious nucleic acids, capable of transmitting genetic information from one cell to another and related to the transforming-principle nucleic acids. Results are reported from investigations of the relation between the appearance of viral nucleic acid to the appearance of the transforming-principle nucleic acid in several Bacillus megatherium cultures. The effect of a number of mutagens on the proportion of virus-producing cells and of antibiotic-resistant mutants was used as the test criteria. Results show that mutagens that cause an increase in the number of antibiotic-resistant cells also cause a similar increase in the number of virus-producing cells. Both types of cells contain a new and different infectious nucleic acid. There appeared no reason to assume that the cells that produce the transforming-principle nucleic acid do so as the result of a mutation, and the cells that produce the virus nucleic acid do so because they were infected some time in the past. (C.H.)

32644 (UCRL-10211(p.16-42)) THE PHYSICS OF SPACE RADIATION. Roger Wallace (California. Univ., Berkeley. Lawrence Radiation Lab.).

The sources of radiation expected to be encountered in space exploration are discussed. These include primary cosmic rays, solar flares, heavy ions, Van Allen radiation belts, and some other possible sources of radiation. Emphasis is placed on the nature of solar flares. Results are summarized from a number of studies on the biological and physical problems expected in space flight. It is concluded that solar-flare protons are the only radiation problem that appears to offer potential hazards for space travel in any way commensurate with those inherent in the travel itself due to propulsion and guidance problems. (C.H.)

32645 (UCRL-10211(p.43-9)) RELATIVE BIOLOGIC EFFECTIVENESS OF 730 Mev PROTON PARTICLES FOR ACUTE LETHALITY OF MICE. C. C. Wang, J. Lyman, and C. A. Tobias (California. Univ., Berkeley. Lawrence Radiation Lab.).

The relative biological effectiveness (RBE) of 730-Mev proton particles was compared to 200 kv x ray. For acute lethality of mice $LD_{50(30)}$ the value is approximately 0.75; for splenic atrophy it is approximately 1, and for rapidity and degree of weight loss following lethal radiation it is approximately 1. (auth)

32646 (UCRL-10211(p.62-8)) CHEMICAL ELEMENTS OF THE BLOOD OF MAN. II. A. THE LEVELS OF SIXTY-SIX CHEMICAL ELEMENTS IN THE SERUM OF OSTENSIBLY HEALTHY ADULT MALES. John W. Gofman, O. F. deLalla, G. Johnson, E. L. Kovich, O. Lowe, D. L. Piluso, R. K. Tandy, and F. Upham (California. Univ., Berkeley. Lawrence Radiation Lab.).

The blood serum of ostensibly healthy adult males was analyzed for mean levels of 66 chemical elements. Data are tabulated. Results are reported from an evaluation of x-ray spectrochemical methods used in the study. (C.H.)

32647 (UCRL-10211(p.69-77)) CHEMICAL ELEMENTS OF THE BLOOD OF MAN. II. B. THE LEVELS OF SIXTY-SIX CHEMICAL ELEMENTS IN DOWN'S DISEASE (MONGOLISM). John W. Gofman, O. F. deLalla, G. Johnson, E. L. Kovich, O. Lowe, D. L. Piluso, R. K. Tandy, and F. Upham (California. Univ., Berkeley. Lawrence Radiation Lab.).

Apparently significant differences were observed for eight elements in males with mongolism. Whether any spurious basis is responsible for the observed differences will become apparent from further study of the problem of reference controls. Should the observed differences truly be specifically associated with the mongolism per se, it will be of interest to speculate upon what possible bearing these findings may have upon the numerous anatomic and functional peculiarities in mongolism. Perhaps as surprising as the eight elements apparently different in mongolism is the fact that the over-all serum elemental pattern is so similar in mongolism to that in reference controls. (auth)

32648 (UCRL-10211(p.78-88)) CHEMICAL ELEMENTS OF THE BLOOD OF MAN. II. C. THE SERUM LEVELS OF SIXTY-SIX CHEMICAL ELEMENTS IN SCHIZOPHRENIA AND ALCOHOLISM. John W. Gofman, O. F. deLalla, G. Johnson, E. L. Kovich, O. Lowe, D. L. Piluso, R. K. Tandy, and F. Upham (California. Univ., Berkeley. Lawrence Radiation Lab.).

The blood serum of two groups of humans with schizophrenia and two groups of alcoholic subjects was analyzed for levels of 66 chemical elements. Data are tabulated and results are contrasted with previous measurements on healthy individuals. (C.H.)

32649 (UCRL-10211(p.89-91)) A PORTABLE DEVICE FOR CONSTANT INFUSION OF THE AMBULATORY PATIENT. Reed Johnson, Edward Dowling, and Donald Van Dyke (California. Univ., Berkeley. Lawrence Radiation Lab.). (UCRL-9958)

The design is described of a portable infusion pump and indwelling venous catheter assembly for use for the constant infusion of drugs to ambulatory patients. The assembly is mounted on a lightweight plastic cast molded to fit the arm. The device is battery-powered and the infusion can be continued for 3 or 4 days without interruption. (C.H.)

32650 (UCRL-10211(p.98-103)) CELL DIVISION AND PHAGOCYTIC ACTIVITY IN LIVER RETICULO-ENDOTHELIAL CELLS. Lola S. Kelly, Barbara A. Brown, and Ernest L. Dobson (California. Univ., Berkeley. Lawrence Radiation Lab.).

Autoradiographs of liver sections from mice given tritiated thymidine were used to identify the cells that were preparing for division, and colloidal saccharated iron oxides was used to identify the active phagocytic cells. It was established that, in livers of mice whose reticulo-endothelial system was stimulated by estradiol, the cells preparing for division and those that had recently divided were actively phagocytic. In livers of mice whose reticulo-endothelial system had been blockaded with saccharated iron oxide, the cells that had phagocytized colloid were able to divide in the process of recovery from blockade. No evidence was found for a stem cell that proliferates and differentiates to provide the active phagocytic population. (auth)

32651 (UCRL-10211(p.104-16)) LIPOPROTEIN FATTY ACIDS AND OIL INGESTION. Alex V. Nichols, Carl S. Rehnborg, Frank T. Lindgren, and Robert D. Wills (California. Univ., Berkeley. Lawrence Radiation Lab.).

Results are reported from preliminary investigations on the influence of safflower and olive oil ingestion on the lipid composition of the major serum lipoprotein classes, the fatty acid composition of the lipoprotein lipids, and the fatty acid composition of the ultracentrifugal protein residue fraction. Significant glyceride increases occur in the $S_f20\text{-}10^5$ and the high density lipoproteins (HDL) following oil ingestion. Fatty acid composition changes occur in the glyceride moieties of the $S_f20\text{-}10^5$, $S_f0\text{-}20$, and HDL after oil ingestion. Marked alterations in the composition of the fatty acids associated with the ultracentrifugal protein residue fraction occur following oil ingestion. The origin of the HDL lipid following oil ingestion is discussed in relation to the metabolism of the $S_f20\text{-}10^5$ lipoproteins. (auth)

32652 (UCRL-10211(p.117-21)) ERYTHROPOIETIC STIMULATION IN THE HYPER-TRANSFUSED GUINEA PIG FOLLOWING INJECTIONS OF HUMAN URINARY ERYTHROPOIETIN. Joseph F. Garcia and John C. Schooley (California. Univ., Berkeley. Lawrence Radiation Lab.).

The 24-hr Fe^{59} incorporation and reticulocyte response of hypertransfused guinea pigs was measured after injection of human urinary erythropoietin. A comparison of results with cytological changes in the marrow and histological changes in the spleen indicates that injection of human urinary erythropoietin can specifically stimulate erythropoiesis in the hypertransfused guinea pig. Bone marrow and spleen, devoid of erythropoietic foci, showed marked erythropoietic activity after erythropoietin injections. (C.H.)

32653 (UCRL-10211(p.122-59)) CELL DIFFERENTIATION AND RADIOPATHOLOGY IN THE WING OF TRIBOLIUM CONFUSUM. James S. Beck (California. Univ., Berkeley. Lawrence Radiation Lab.).

Results are reviewed from a number of studies on the effects of ionizing radiation administered at various times on development in widely varying animal forms. Data are presented from studies on cell differentiation and pathological effects observed in the wing of the flour beetle, Tribolium confusum, after exposure of larvae, pupae, and adults to various doses of x radiation. Observations were correlated on microscopic transverse sections and whole wing preparations. The only consistently apparent deformities elicited by x irradiation were deformities of membranous wings and the elytra. This response was found to be reproducible and proportional to dosage. The characterizing nature of the deformity was investigated in neutron-activated and control wings. The deformed wings showed 1.7 times as much phosphorus as control wings and 1.3 times as much carbon as control wings. Morphological differences in the developing wings were observed by both light and electron microscopy. Morphogenesis of the wing was shown to be quite radiosensitive at certain critical times. Radioinduced aberrations in timing and development are described. (143 references.) (C.H.)

32654 (UCRL-10211(p.160-7)) ISOLATION AND ESTIMATION OF SERUM ORGANICALLY-BOUND IODINE. I. EFFECTS OF THE REMOVAL OF IONS FROM SERUM PROTEINS. Gilles La Roche, Charles Oakes, and Paul Blanquet (California. Univ., Berkeley. Lawrence Radiation Lab.).

Two methods for removal from blood serum of free ions, including iodide, were used in an effort to study their effects on serum proteins: one was by passage on an anion-exchange resin and the other by dialysis. Passage on CG-45 resin and dialysis seems to sharpen the electrophoretic pattern. Sixteen-hour dialysis in the cold seems to induce a certain degree of protein denaturation, which is discussed. Use of CG-45 to remove serum free ions including iodide seems to represent an elective procedure because it is very rapid and does not appear to alter serum proteins significantly. (auth)

32655 (UCRL-10211(p.168-85)) A METHOD FOR THE PRODUCTION OF CONCAVE GRADIENTS FOR USE IN COLUMN CHROMATOGRAPHY AND ITS APPLICATION TO THE SEPARATION OF PHOSPHOLIPID AND NEUTRAL LIPID MIXTURES WITH SILICIC ACID COLUMNS. Gary J. Nelson (California. Univ., Berkeley. Lawrence Radiation Lab.).

An automatic method utilizing concave gradient elution for the column chromatographic separation of lipid mixtures, particularly phospholipids, is described in detail. The gradient in this system is produced by an automatic pumping system using accurate, controlled-volume pumps and variable pumping rates. A discussion of the theoretical aspects of gradient elution in relation to non-linear absorption isotherms is included, and several chromatographic runs using the system are presented. The system is capable of excellent resolution of naturally-occurring phospholipid mixtures and is quite reproducible. Considerable flexibility is available in the shape of the gradient produced by the pumping system, allowing modification for particular tissue extracts containing phospholipids in varying ratios. The system is completely automatic and, once a run is started, operates untended until completion. (auth)

32656 (UCRL-10211(p.186-92)) IMMUNOLOGIC STUDIES ON THE MECHANISM OF ACTION OF ERYTHROPOIETIN. John C. Schooley and Joseph F. Garcia (California. Univ., Berkeley. Lawrence Radiation Lab.).

Injections into normal mice of serum obtained from rabbits previously immunized with human urinary erythropoietin results in a progressive daily decrease in the relative numbers of erythroid cells in the bone marrow. Injections of this serum into polycythemic mice 24 to 44 hours after the initiation of a wave of erythropoiesis with erythropoietin has no effect on the magnitude of the erythropoietic response, although injections of the serum one hour before or at the time that exogenous erythropoietin is administered completely abolished the erythropoietic response. These results support the concepts that erythropoietin is involved in the normal regulation of red cell production and that this regulation is the result of the effect of erythropoietin on the differentiation of stem cells. Some speculative interpretations of the effect of injections of the immune serum in polycythemic mice during the first 18 hours after the injection of exogenous erythropoietin are also presented. (auth)

32657 FLASH BLINDNESS PROTECTION. J. H. Hill and Gloria T. Chisum (U. S. Naval Air Development Center, Johnsville, Penna.). Aerospace Med.,33: 958-64(Aug. 1962).

The time required to recover visual sensitivity following exposure to high-intensity, short-duration adapting flashes was measured. Adapting flashes of 33 to 165 microseconds and 9.8 milliseconds in duration with luminances up to 8.6 log mL were used. Visual sensitivity was determined by the resolution of gratings requiring acuities of 0.13 and 0.33 at display luminances from −2.50 to 2.25 log mL. Recovery time decreased as display luminance increased. Recovery time increased (a) with increases in acuity level at display luminances below 0.5 log mL; and (b) with increases in either the luminance or the duration of the adapting flash. Duration contributed less to the decrease in visual sensitivity than would be predicted on the basis of Bloch's Law. On the basis of these findings, recommendations were made regarding flash blindness protective equipment and recovery of visual sensitivity. (auth)

32658 RADIATION ENTERITIS AS A COMPLICATION IN RADIOTHERAPY OF CERVICAL CANCER. L. McGowan and N. E. McGowan (Loyola Univ., Chicago). Am. J. Digest. Diseases, 7: 523-9(June 1962).

One of the most frequent complications of radiation therapy for cervical cancer is radiation enteritis. Its pathology, prevention, and treatment are discussed. The common problem in bowel injury from radiation is damage to the vasculoconnective tissue. The single most important modification of therapy that has decreased this damage is the realization of the necessity for administration of the total dose in smaller increments over a longer period. Radium should not be given in one application. Use of a smaller quantity of radium in 2 or 3 insertions prevents serious damage to nearby structures. The successful external irradiation of cervical cancer necessitates the use of doses sufficiently great to have an effect on surrounding normal structures. The portal through which external radiation therapy is given should be no larger than necessary. The midline area may be shielded during external irradiation so as to avoid overirradiation of the lower bowel and bladder with combined radium and external radiation therapy. Clinical proctosigmoiditis was 4 times less frequent in patients undergoing radiation therapy for cervical cancer with the aid of dietary regulation. The dietary program contains approximately 2000 to 2500 cal. The daily ration includes 100 g of protein, 200 to 300 g of carbohydrate, 130 to 140 g of fat, and supplements of minerals and vitamins, distributed in frequent small feedings and not in the normal 3 daily meals. The cancer patient is able to consume more food and protein without undue distention if 5 or more feedings per day are given. The adequate oral intake of fluids during radium administration is important. The intake of solid food may be decreased so that the necessity for bowel movements is minimized. (H.H.D.)

32659 RENAL HOMOTRANSPLANTATION IN MAN AFTER RADIATION OF THE RECIPIENT: EXPERIENCE WITH SIX PATIENTS SINCE 1959. J. Hamburger, J. Vaysse, J. Crosnier, J. Auvert, C. M. Lalanne, and J. Hopper (Hopitaux Necker, Paris). Am. J. Med., 854-71(June 1962).

A healthy kidney of a parent or sibling was transplanted in the sublethally irradiated (430 to 460 rad) recipient with advanced chronic renal insufficiency. Three of the 6 cases showed prolonged tolerance to the grafter kidney, although 1 of the 3 died following further radiation therapy. In 2 of the unsuccessful cases, the graft was rejected within 48 hr, and a 3rd case died from an early infection. Renal function appeared to be normal after more than 1 yr in the 2 surviving successful cases, and biopsy showed normal glomerular structure. Radiation treatment was

not accompanied by a diminution of pre-existing circulating antibodies (blood-group isohemagglutinins), but it apparently reduced formation of antibodies in response to antigens in the transplanted kidney. In cases of early rejection of the graft, differences were noted in leukocyte agglutination reactions between donor and recipient, but in all cases the major erythrocyte blood groups were the same in the 2 individuals. (H.H.D.)

32660 RECTAL AND BLADDER INJURIES IN RELATION TO RADIATION DOSAGE IN CARCINOMA OF THE CERVIX; A 5-YEAR FOLLOW-UP. Hans L. Kottmeier (Radiumhemmet, Stockholm). Am. J. Obstet. Gynecol., 82: 74-82(July 1961).

A survey was made of 500 patients with invasive carcinoma of the cervix treated at the Radiumhemmet, who were followed for more than 5 yr with particular attention to the development of radiation injuries. Increased dosage of radiotherapy used on an experimental basis during the time of this study appears to be responsible for improvement in survival rates but was accompanied by a higher rate of injuries. There is a direct correlation between dosage levels in bladder and rectum and injury rate. A dose of more than 5,000 gamma r or a total dose of more than 6,000 r to the rectal mucosa is accompanied by a very high injury rate as is a dose of more than 6,000 gamma r or more than 9,000 total r to the bladder. Because of these results, treatment of carcinoma of the cervix, beginning in 1956, was modified on the basis of direct dosage measurements in the bladder and rectum at the time of treatment. Currently, 4,000 gamma r to an area of more than 2 cm in diameter is considered the maximum permissible dose in the average patient. There is also a correlation between intensity of treatment and injury rate in both the bladder and rectum. A total of 2,400 gamma r to the rectum in 24 hr is the maximum intensity which is now permitted. Both rectum and bladder injuries are usually transient, with those in the rectum generally occurring sooner than those in the bladder. The incidence of permanent disability due to therapy in this series (1% of patients treated) is very low compared with the overall 5-yr survival rate of 54.5%. (H.H.D.)

32661 THE EFFECTS OF FEEDING IRRADIATED BEEF TO DOGS. II. REPRODUCTION AND PATHOLOGY. Elwood F. Reber, Om P. Malhotra, Paul D. Beamer, Horace W. Norton, and Julius P. Kreier (Univ. of Illinois, Urbana). Am. J. Vet. Res., 23: 74-6(Jan. 1962).

Dogs were fed a ration containing 35% beef (total solids) for 104 weeks. Three treatments of beef were tested: nonirradiated, irradiated with 2.79 Mrad, and irradiated with 5.58 Mrad. Feeding irradiated beef had no significant effect on the level of hemoglobin, red blood cell, white blood cell, or differential white blood cell counts in 14 analyses made during the 104 weeks. When organ weights were compared on the basis of per cent of the body weight, there was no difference due to treatment. Histopathologic examination of the tissues did not reveal consistent lesions that could be associated with the feeding program. The radiation dose necessary for sterilization and preservation of beef is considered to be 4.8 Mrad. Beef irradiated at the 5.58 Mrad level was included in the test for wholesomeness to evaluate any accentuated radiation-induced changes. No gross abnormalities or ill effects were observed due to feeding irradiated beef. Under the conditions of this experiment, beef irradiated with 2.79 or 5.58 Mrad was not toxic and is considered to be wholesome. (H.H.D.)

32662 EQUIVALENCE OF Sr AND Ca IN RELATION TO THE PARATHYROID. L. Cerrini and E. Mueller (Università, Milan). Atti accad. med. lombarda, 16: 328-32(Apr.–July 1961). (In Italian)

Hyperparathyroidism, induced in rats by feeding a Ca-deficient diet for 30 days, could be corrected by feeding a diet containing Sr salts as well as by one containing Ca salts. The growth curves of rats fed a Ca-deficient diet supplemented with Sr could not be distinguished from those of rats on a normal diet or rats on a Ca-supplemented diet, whereas rats on a Ca-deficient diet were 20% below normal body weight by the 20th day. The number of nuclei per unit area of parathyroid tissue sections was 86.5 in control rats; 82.5 in Ca-deficient, Sr-supplemented rats; and 57.5 in Ca-deficient rats. It is evident that Sr can replace Ca in the role of parathyroid homeostasis. (H.H.D.)

32663 ANAESTHESIA FOR THE IRRADIATED PIG. A STUDY IN REMOTE CONTROL. J. Fowler, D. W. Hill, R. L. Morgan, J. F. Nunn, Barbara Weaver, and R. F. Woolmer (Royal Coll. of Surgeons, London). Brit. J. Anaesthesia, 34: 327-31(May 1962).

As a preliminary investigation of the comparative effects of the neutron beam from a 45-in. cyclotron with x rays from an 8-Mev linear accelerator, an anesthetic technique that would assure complete immobilization of the animals for several hours was sought. Choice of anesthetic technique was influenced by the nature of the experimental animal, and by the need for a nonexplosive agent (because of the proximity of high voltage electrical apparatus) which would provide safe anesthesia for long periods by remote control. For premedication, phenothiazine derivatives were chosen because they produce sedation without undue respiratory depression and because their effects are long lasting. Promazine (2 mg) and promethazine (1 mg per lb (0.45 kg) body weight) were given together by intramuscular injection 1½ hours before induction of anesthesia. Parasympathetic depression was obtained with atropine sulfate (0.32 mg given by intramuscular injection after induction). Anesthesia was induced with intravenous thiopentone (250 mg for a 50-lb pig). On some occasions, to reduce the number of venepunctures, anesthesia was induced with cyclopropane. Pig and anesthetic apparatus were conveyed into the linear accelerator chamber, where the animal was irradiated with 8-Mev x rays. The whole process of anesthesia, transfer, positioning and irradiation took 5 to 6 hr, and during much of this time the animal was inaccessible to the operating team. An optimal level of anesthesia was maintained by observing a stethograph which recorded the pig's respiratory changes. Rises in body temperature during irradiation were noted in some instances, and this was subsequently avoided by reducing ambient temperature and humidity. (H.H.D.)

32664 THE USE OF GAMMA RADIATION FROM COBALT-60 IN THE CONTROL OF DISEASES OF THE HONEY-BEE AND THE STERILIZATION OF HONEY. H. Katznelson and J. A. Robb (Canada Dept. of Agriculture, Ottawa). Can. J. Microbiol., 8: 175-9(Apr. 1962).

Honeycomb and honey heavily contaminated with spores of Bacillus larvae (agent of American foulbrood disease of honeybee larvae) were exposed to gamma radiation from Co^{60}. Sterility was achieved by a dose of 1.5×10^4 to 2.0×10^6 rad. Sugar-tolerant yeasts in honey were effectively destroyed by a dose of 1×10^6 rad whereas cysts of Nosema apis (agent of nosema disease of adult bees) were inactivated by a dose of 0.2×10^6 rad. The honey samples before testing were golden-brown and irradiation caused a progressive decrease in the intensity of this color resulting in a straw-colored liquid on treatment with a dose of 2

Mrad. There was a slight change in honey flavor and gas evolution occurred in all treated samples. The results show that pasteurization or sterilization of honey can be achieved with relatively little difficulty and with a comparatively small irradiation unit. However, a slight intensification of flavor as a result of gamma irradiation and a distinct change from a dark to a light color requires further study in relation to the food and market value of the honey. (H.H.D.)

32665 THE PURITY OF RADIOIODIDE-I^{131} ASSESSED BY IN VIVO AND IN VITRO METHODS. D. M. Fawcett, G. L. Olde, and L. E. McLeod (Alberto Hospital, Edmonton, Can.). Can. Med. Assoc. J., 86: 965-70(May 26, 1962).

Anomalous results from in vitro studies of thyroid metabolism have led to investigation of the purity of commercial samples of I^{131}. Analysis of 30 I^{131} preparations by paper chromatography showed that samples supplied without cysteine preservative contain appreciable quantities of non-iodide radioactivity. From 41 to 94% of the radioactivity was non-iodide. Extraneous radioactivity was essentially absent from I^{131} supplied with cysteine. It was converted to iodide-I^{131} by 10^{-3} M cysteine or iodide but not by incubation at pH 2. The average thyroid uptake of I^{131} containing extraneous radioactivity was significantly lower than the uptake of I^{131} free from non-iodide impurity in 16 human subjects measured under controlled conditions and in a random group of 669 patients. Incubation of samples of I^{131} containing non-iodide radioactivity with tyrosine and $CuCl_2$ resulted in nonenzymatic formation of monoiodotyrosine-I^{131} either in the presence or absence of thyroid homogenate. Enzymatic formation of monoiodotyrosine-I^{131} by thyroid homogenates could be demonstrated only when I^{131} free from extraneous activity was used. (H.H.D.)

32666 HETEROTRANSPLANTATION OF HUMAN HEPATOMA IN THE CHICK-EMBRYO CHORIOALLANTOIC MEMBRANE AND THE IRRADIATED RAT BRAIN. R. Baylet and R. Camain (Faculté Mixte de Medicine and Pharmacology, Dakar, Africa). Compt. rend. soc. biol., 156: 324-6(June 12, 1962).

Tumor cells from a human hepatoma could readily be transplanted in chick chorioallantoic membrane. The tumor cells proliferated rapidly in the mesenchymal layer of the membrane. Successful takes of the grafted tumor can be attributed to the immunologic unresponsiveness of the embryonic chick. In contrast, the tumor could not be successfully transplanted in the brain of rats pretreated to block antibody formation, i.e., with 320 r and intramuscular injection of 25 mg cortisone. In each of the 5 rats studied, intraventricularly injected hepatoma cells were injected by the recipient. (H.H.D.)

32667 PENDULUM IRRADIATION OF THE PITUITARY WITH ULTRAHARD RADIATION. Hans Ludwig Keller (Universität, Erlangen, Ger.). Deut. med. Wochschr., 87: 1110-15(May 25, 1962).

Comparative dosimetry studies were conducted on human pituitary irradiation by Co^{60} γ rays and the ultrahard radiation of a 17-Mev betatron. A wax-filled human cranium was used as a phantom and radiation was directed toward the pituitary region over a 200° sagittal arc (pendulum angle). To produce a local dose of 200 r required ~3 min with 2000 c Co^{60} as compared with 3 to 5 min with the betatron. Dose gradient data showed that ~25% of the Co^{60} radiation was dissipated in cranial and superficial structures compared with only 10% of the ultrahard radiation, so that the dose reaching the target zone was considerably greater with the latter irradiation technique. The use of ultrahard radiation in the treatment of pituitary tumors and hyperactivity, in preference to surgical and radioactivity-implantation methods, is discussed. The possible use of this method in treatment of Parkinson's disease is also considered. (H.H.D.)

32668 RADIO-NEPHROGRAPHY AND RENAL SCINTOGRAM; COMBINED INVESTIGATION OF RENAL FUNCTION AND STRUCTURE. W. Horst, H. Roesler, C. Schneider, and B. Conrad (Universität, Hamburg). German Med. Monthly, 7: 186-8(June 1962).

The combined application of 2 radioisotope methods is described. Renal function is evaluated by measuring the disappearance from the blood of intravenously injected I^{131}-labeled Diodone. Suprarenal scanning can also be used to follow clearance of the test substance from the kidney. The evaluation of renal structure is carried out by the scintogram after injection of Hg^{203}-labeled mersalyl. This isotope is well suited for scintographic work since it emits sufficiently hard gamma radiation (0.279 Mev) and has a convenient half life (~48 days). The labeled compound is quickly removed from blood (elimination half time 60 min) but remains in the kidney for a suitable period (renal half time 120 to 160 min). When it is used for scintigraphy, the general body background is only 25 to 30% of that over the kidney. The area of radioactivity on the scintogram provides an oval figure showing the relative size of the kidney, and reveals the presence of congenital malformations, such as horseshoe kidney, and acquired lesions, such as contracted kidney and hydronephrosis. The radiation hazard is less than in pyelography. A single injection of 500 μc mersalyl-Hg^{203}, a higher dose than is actually used, was estimated to give the following exposures: total kidney β radiation, 0.33 rad; total-body β radiation, 9.2 mrad; and γ radiation to the gonads (from the bladder), 68 mrad for ovary and 35 for testis. (H.H.D.)

32669 USE OF RADIOACTIVE PHOSPHATE TO EVALUATE BLOOD SUPPLY TO THE UPPER FEMUR. Alexander Nedwich and Irvin Stein (Albert Einstein Medical Center, Philadelphia). J. Albert Einstein Med. Center, 10: 3(Jan. 1962).

Adult male dogs were submitted to selective surgical procedures in order to evaluate the degree of vascular damage imposed upon the head of the femur. P^{32} was injected intravenously at the time of the operations. Subsequent determinations of radioactivity were made and the results compared with autoradiographs. (H.H.D.)

32670 AUTORADIOGRAPHY AND MICRORADIOLOGY OF BONE. Jennifer Jowsey (Albert Einstein Medical Center, Philadelphia). J. Albert Einstein Med. Center, 10: 5(Jan. 1962).

A study was made of occupationally radium-exposed patients and patients in a state mental hospital who received carefully measured weekly injections of radium over long periods of time. These formed a unique group permitting study of the effects of radium on bone tissue and of mineral metabolism of bone. The most striking feature of radium-burdened bone is the appearance of areas of hypermineralization. The central haversian canals may be completely mineralized and the lacunae of the osteocytes may be filled with bone material. There is often an unusual amount of rapid bone resorption. None of these features are peculiar to radium-burdened bone but are found to different extents in other diseased bone. Autoradiographic methods demonstrated the turnover of the mineral fraction of the skeleton. Not only are complete microscopic areas of bone replaced in normal turnover processes, but the mineral throughout the skeleton appears

to be slowly renewed by a process of long-term exchange. (H.H.D.)

32671 IRRADIATED MEATS. I. STORAGE STABILITY OF COOKED AND RAW MEAT. Gerald D. Gernon, Jr. and Richard W. Seaton (Quartermaster Food and Container Inst. for the Armed Forces, Chicago). J. Am. Dietet. Assoc., 41: 20-4(July 1962).

A comparison was made of the storage stability of irradiated (2.1 Mrad) cooked and raw meats. Stability during storage was evaluated periodically by determining the relative preference for the irradiated meat items by human subjects. Preference for cooked irradiated meats over uncooked irradiated meats stored at room temperature became evident early. After 9 months' storage, the raw meats at 72° F had deteriorated in terms of low preference scores and quality to the point where they were eliminated from the 16-month evaluations. Cooked items stored at 72° F were slightly preferred over the raw samples held at 40° F, but only in 2 cases, beef roasts and pork chops, were the cooked samples significantly preferred after 9 months' storage. However, after 16 months' storage, for 7 of 9 meats tested, the cooked samples were significantly preferred over the refrigerated raw samples. Thus, cooking prior to radiation increased the storage stability of the meats. Repacking for the 72-hr clearance period prior to sensory evaluation had no effect on preference ratings. Hence the suppositions that resealing might reduce oxidative changes, while leaving the cans open might permit disposal of unpleasant volatiles could not be demonstrated. The technological advantage of heat inactivation of the enzymes in meat before exposure to sterilization by gamma radiation is emphasized. (H.H.D.)

32672 IRRADIATED MEATS. II. EFFECTS OF COOKING, STORAGE TEMPERATURE, AND BROTH PACK ON PALATABILITY. Gerald D. Gernon, Jr. and Richard W. Seaton (Quartermaster Food and Container Inst. for the Armed Forces, Chicago). J. Am. Dietet. Assoc., 41: 25-8(July 1962).

Frozen beef, pork, and chicken were irradiated (4.5 Mrad) and periodically evaluated for palatability by a trained sensory panel. Visual differences were apparent, but panelists could not differentiate between samples and lots for each meat when a loss of texture occurred. Beef roasts broke apart on handling after only 3 months' storage, indicating that fragility had increased. Pork roasts and chicken thighs showed good stability over the range of storage time, 3 to 12 months, and temperatures (72 or 90° F). All 3 meats cooked to an internal temperature of 120 to 130° F averaged higher ratings than meats heated to 170 to 180° F. Pork roasts and chicken thighs packed without broth were preferred at the earliest storage withdrawals but later were less preferred than samples packed with broth. These findings support the expectation that cooked meats, such as pork and chicken, when exposed to dosages of irradiation in the range of sterilization (4.5 Mrad), maintain at least moderate palatability over extended storage. The palatability ratings for these items were generally comparable with those found in meat products irradiated to 2.1 Mrad. Textural deterioration was more evident, however, at the higher dose. Partial hydrolysis of the connective tissues during steam cooking and over storage, in addition to irradiation, contributed to this increased fragility. (H.H.D.)

32673 COMPARATIVE STUDIES IN ROUS SARCOMA WITH VIRUS, TUMOR CELLS AND CHICK EMBRYO CELLS TRANSFORMED IN VITRO BY VIRUS. III. MALIGNANCY IN VIVO OF CELLS TRANSFORMED IN VITRO BY VIRUS. Herbert R. Morgan and Angelo P. Andrese (Univ. of Rochester, N. Y.). J. Exptl. Med., 116: 329-36(Sept. 1, 1962).

Chick embryo fibroblasts could be rendered malignant by in vitro infection with Rous sarcoma virus. Such cells produced tumors when injected into susceptible chicks and the sex chromatin of the tumors corresponded to that of the donor rather than the recipient. The sex chromatin marker was found to be a reliable index for identification of the origin of tumor cells, and it was shown that x irradiation of cells with doses (~5000 r) sufficient to prevent their multiplication allows formation of tumors, following injection of infected, irradiated cells, which have the sex chromatin pattern of the recipient. In this case the tumors arise by escape of virus from the irradiated cells. When tumors induced by transferred cells are serially transferred in recipients of the opposite sex, they gradually convert to the sex of the recipient, indicating that the tumors are not indefinitely transplantable. (H.H.D.)

32674 THE ROLE OF ANTIBODY, DELAYED HYPERSENSITIVITY, AND INTERFERON PRODUCTION IN RECOVERY OF GUINEA PIGS FROM PRIMARY INFECTION WITH VACCINIA VIRUS. Robert M. Friedman, Samuel Baron, Charles E. Buckler, and Robert I. Steinmuller (National Institutes of Health, Bethesda, Md.). J. Exptl. Med., 116: 347-56(Sept. 1962).

Methotrexate and x radiation were used in guinea pigs to block the development of delayed hypersensitivity and of antibody to vaccinia virus during experimental infection. Animals whose specific responses were blocked by x radiation and methotrexate recovered from vaccinia virus infection as rapidly as nontreated control animals. A virus-inhibiting substance with the properties of interferon was present in skin of untreated and methotrexate- and radiation-treated animals infected with vaccinia virus. These results are consistent with the hypothesis that, while antibody is important in resistance to secondary viral infections, it is not essential to recovery from primary viral infections. The finding that normal recovery occurred in the absence of delayed hypersensitivity suggests that the immune responses are not required for recovery from primary infections with vaccinia virus. In contrast to previous findings of suppression of delayed hypersensitivity to soluble antigens by methotrexate alone, complete inhibition of the development of delayed hypersensitivity to the strong antigenic stimulus provided by a replicating virus required treatment with both methotrexate and x radiation. That treatment with x radiation and methotrexate in the doses employed does not inhibit vaccinia infection in animals is indicated by the similarity of virus elimination in treated and in untreated groups and by the finding that methotrexate did not suppress vaccinia virus infection of rabbits. (H.H.D.)

32675 β-GALACTOSIDASE FORMATION FOLLOWING DECAY OF P^{32} IN ESCHERICHIA COLI ZYGOTES. Monica Riley and Arthur B. Pardee (Univ. of California, Davis). J. Mol. Biol., 5: 63-75(July 1962).

The effect of P^{32} on the phenotypic function of a gene was studied in differentially labeled E. coli zygotes. P^{32} decays outside of the gene governing β-galactosidase synthesis were able to prevent function of the gene; these decays did not irreversibly damage the gene itself. Position of the P^{32} in the zygote was all-important in determining the effectiveness of P^{32} decays, rather than simply the numbers of P^{32} atoms contained in the bacterial nucleic acid. Zygotes could be differentially labeled in such a way that P^{32} decays were effective only when they occurred in genetic material cis to the gene in question. The destructive

effect of the P^{32} was restricted to the chromosome in which decay occurred and was not cytoplasmic in that it did not cause a loss of function of genes on other genetic segments. Decays in the F^- bacteria could be effective in halting expression of the injected gene for β-galactosidase when the zygotes were labeled completely in their F^- material. P^{32} decay is thought to cause phenotypic inactivation of a large segment of chromosome by a mechanism that does not involve intervention of cytoplasmic agents. (H.H.D.)

32676 PURIFICATION AND BIOLOGICAL CONTROL OF A PREPARATION OF INSULIN LABELED WITH IODINE-131. Y. Arnould and J. R. M. Franckson (Université Libre, Brussels). Pathol. Biol. Semaine Hop., 10: 1171-7(July–Aug. 1962).

An evaluation was made of the denaturation, degradation, and biological inactivation of insulin accompanying its labeling with I^{131}, and modifications in the labeling procedure are described. These modifications entail removal of I not bound to protein and separation of insulin-I^{131} from degraded protein. Inorganic and organic nonprotein I can be removed by dialysis or chromatography on Amberlite resin; in the 1st procedure the product contained 16 ± 3% I and in the 2nd, 3 to 12%. Separation of insulin-I^{131} from degraded protein was achieved by paper chromatography or cellulose column chromatography. Paper chromatography revealed 3 radioactive fractions, the intermediate peak (R_f 0.2) corresponding to that of native insulin and accounting for 60% of the total radioactivity. Biological tests on insulin-I^{131} (in vivo in dogs and in vitro on rat epididymal fat) showed that 20 to 70% of its physiological activity is lost by iodination. The described technic yields a preparation with 0.65 atoms I per molecule insulin with a specific activity of 37 μc/unit. (H.H.D.)

32677 THE RADIOMIMETIC ACTIVITY OF CHELATED FERROUS ION. C. Nofre, A. Cier, and A. Paquelier (Centre Recherches, Service Santá Armées, Lyon). Pathol. Biol. Semaine Hop., 10: 1203-11(July–Aug. 1962).

The toxicity of various products and systems which form hydroxyl free radicals was investigated in mice. The following were tested: H_2O_2, Fe(II) chelated with Na ethylenediaminetetraacetate (EDTA) and treated with ascorbic acid (in equimolar amounts); Fe(II)-EDTA + H_2O_2, and Fe(II)-EDTA + H_2O_2 + ascorbic acid. The relative toxicities of these 4 preparations, injected intraperitoneally in mice, were: 1.0, 12.0, 36.0, and 45.5, respectively. The relative toxicity of Fe(II)-EDTA was 10.0; its 30-day LD_{50} in mice was 0.72 millimoles/kg body weight, compared with 7.2 for H_2O_2 and 0.16 for Fe(II)-EDTA + H_2O_2 + ascorbic acid. The toxic effect of these preparations closely resembles that of ionizing radiation. The triphasic mortality curve shows peaks at 2, 8, and 12 days. The acute effects are characterized by excitation followed by paralysis, convulsions, and death. Chronic effects with lower doses include weight loss, persistent diarrhea, hemorrhages, and infections. Leukocytes (both polymorphonuclear and mononuclear) in circulating blood fall sharply the 1st 5 days, then rise slightly by the 15th day, and drop again by the 20th day after injection of Fe(II)-EDTA. The pyknotic and antimitotic effects in duodenal epithelial cells and lymphocytes caused by 1.5 milliatoms Fe(II) per kg were closely simulated by irradiation with 750 r. The radioprotective agent cysteinamine when injected 15 min before the various chelated Fe(II) preparations reduced mortality ~50%. In mice injected with 0.1 milliatoms Fe (II) per kg (as Fe(II)-EDTA) immediately before irradiation with 550 rad from a Co^{60} source, the mortality was 70% compared with 20% in untreated-irradiated mice. Thus, this subtoxic dose of Fe(II)-EDTA has a pronounced radiosensitizing effect. The paramagnetic properties of these Fe(II) chelates suggests that they potentiate radiation injury by the paramagnetic extinction effect, such as has been proposed for the radiopotentiation action of oxygen, favoring the probability of singlet-triplet transitions of organic molecules excited by irradiation. Thus, the chelates prolong the life of the excited state and facilitate secondary ionization reactions. (H.H.D.)

32678 HEMOSTATIC EFFECTS OF HETEROLOGOUS PLATELETS IN THROMBOCYTOPENIC RATS. Albert J. Roy, Hiroku Yoshimura, and Isaac Djerassi (Children's Cancer Research Foundation, Boston; Children's Hospital Medical Center, Boston; and Harvard Medical School, Boston). Proc. Soc. Exptl. Biol. Med., 111: 15-18(Oct. 1962).

Fresh human platelets transfused into irradiated thrombocytopenic rats are removed from the circulation within 2 to 3 hours. The output of red blood cells into the lymph is reduced (–70%) despite the declining platelet count. The effects of fresh rat platelets are both more marked and more consistent. Species-specificity may perhaps account for the lesser activity of heterologous platelets. (auth)

32679 MEASUREMENT OF TOTAL BODY IRON^{59} IN ANIMALS USING WHOLE-BODY LIQUID SCINTILLATION DETECTORS. Ralph H. Forrester, Marcel E. Conrad, Jr., and William H. Crosby (Walter Reed Army Inst. of Research, Washington, D. C.). Proc. Soc. Exptl. Biol. Med., 111: 115-21(Oct. 1962).

Iron absorption and total–body retention was measured in rats using Fe^{59} and a whole-body liquid scintillation counter. Whole-body liquid scintillation counting provides an efficient and reliable method of assaying small quantities of γ-emitting nuclides in live animals and biologic specimens. (auth)

32680 KINETICS OF MEGACARYOCYTE PROLIFERATION. L. E. Feinendegen, N. Odartchenko, H. Cottier, and V. P. Bond (Brookhaven National Lab., Upton, N. Y.). Proc. Soc. Exptl. Biol. Med., 111: 177-82(Oct. 1962). (BNL-6275)

The kinetics of the megacaryocytic cell line of the rat bone marrow were studied using tritiated thymidine as a cell label. The changes in the percentage of labeled cells as a function of time after injection of the tracer were registered separately for arbitrarily chosen successive recognizable stages of megacaryocytic differentiation. Emphasis is put on the development of initially labeled cells into a stage of maturation corresponding to initially non-labeling cell forms. The transit time for the most immature recognizable stage of megacaryocytic development to megacaryocytic disintegration is approximately 40 hours. Evidence was obtained that the recognizable megacaryocytic elements originate from unrecognized precursors which continuously synthesize DNA for a period of at least 1 to 3 days prior to maturation into recognizable megacaryocytic precursors. The immature megacaryocytic cells able to synthesize DNA take up more H^3 thymidine than the rest of the bone marrow cells. This is consistent with polyploidy. The process of nuclear lobulation is not accomplished by the end of DNA synthesis, thus being comparable to nuclear segmentation in neutrophilic granulocytes. This latest phase of maturation is relatively long (approximately 25 to 30 hours) as compared to the phase during which recognizable megacaryocytic precursors which recognizable megacaryocytic precursors are able to synthesize DNA (less than 15 hours). (auth)

32681 RADIATION DOSE-RESPONSE CHARACTERISTICS OF LEUCOCYTES IN THE MOUSE. Willie W. Smith,

Ilo M. Alderman, Carol A. Schneider, and Jerome Cornfield (National Cancer Inst. and National Heart Inst., N.I.H., Bethesda, Md.). Proc. Soc. Exptl. Biol. Med., 111: 182-6 (Oct. 1962).

In mice, changes in dose in the sublethal range could be detected by means of lymphocyte counts 2 to 4 days after irradiation with an estimated accuracy of 66 rads, but as the dose was increased it soon became impossible to distinguish between doses by means of lymphocyte counts. Changes in dose in the range 0 to LD_{50} could be detected by granulocyte counts 3 days after irradiation with an estimated accuracy of 145 rads and 4 days after irradiation, 107 rads. Prior injection of endotoxin did not improve the accuracy of dose discrimination 3 days after irradiation. Four days after irradiation accuracy was increased in the higher dose range but usefulness of the procedure was limited by the acutely toxic effect of the endotoxin on lethally irradiated mice. (auth)

32682 UPTAKE OF STRONTIUM-85 BY ALFALFA. C. C. Lee (Univ. of Saskatchewan, Saskatoon, Can.). Science, 138: 41-2(Oct. 1962).

Experiments with alfalfa were carried out to study the possibility of changes with time in the availability of radiostrontium in soil. After the soil was treated once with Sr^{85}, the first crop was harvested after 60 days of growth. Four subsequent crops, cut at successive 4-week intervals, were examined. The difference in uptake between the second and fifth crops was statistically significant, suggesting that some fixation of Sr^{85} may occur in the soil. The effects of various applications of ammonium dihydrogen phosphate, monocalcium phosphate, calcium chloride, and potassium chloride on the uptake of Sr^{85} by alfalfa were also investigated. Of the experiments carried out, only the treatment with 1.0 meq of potassium per 100 g of soil resulted in a statistically significant reduction in strontium uptake. (auth)

32683 MINIMAL DOSAGE OF IODIDE REQUIRED TO SUPPRESS UPTAKE OF IODINE-131 BY NORMAL THYROID. Krishna M. Saxena, Earle M. Chapman, and Charles V. Pryles (Harvard Medical School, Boston and Boston Univ.). Science, 138: 430-1(Oct. 1962).

Sodium iodide was given in increasing doses to mentally defective children with normal thyroid function. Maximal suppression of iodine-131 uptake was achieved with 1500 to 2000 micrograms of iodide per square meter of body surface per day, but quickly rebounded when iodide was discontinued. This minimal effective dose is important if counter-measures against fallout are employed. (auth)

32684 EXPERIMENTAL DATA CONCERNING THE POSSIBLE USE OF STERILIZATION BY RADIATION IN PRODUCING BACTERIAL PREPARATIONS. D. R. Kaulen. Trudy Tashkent. Konf. po Mirnomu Ispol'zovan. At. Energ., Akad. Nauk Uzbek. S.S.S.R., 3: 88-93(1961).

The production of antidiphtheric preparations and radiosterilization of nutrient media, toxoid, and antitoxic sera is discussed. The media were exposed to γ rays in doses of 0.6, 1, and 1.5 million r. With the naked eye the irradiated liquid media appeared to be more transparent than autoclaved media; solid media acquired a transient unpleasant smell. No physico-chemical changes were observed: the pH as well as the total, amino-, and protein-N remained unchanged. The yield of toxin was never lower and sometimes even higher than the yield in the control media. Irradiation of previously autoclaved media, however, caused a loss in the nutrient properties of the media. The immunogenic and antigenic properties of the toxoids prepared from the above toxins proved to be at least equal if not superior to those of the control preparations. On solic nutrient media, whether autoclaved and then irradiated or only irradiated the growth of bacteria was always more abundant than on media only sterilized in the autoclave. In the case of some media which had to be sterilized by fractionated heating over 3 days, radiosterilization proved to be a time-saving method. The gross appearance of crude toxoid sterilized by radiation as well as its antigenic and immunogenic properties remained unchanged; purified adsorbed toxoids, however, turned dark brown and lost up to two thirds of their antigenic activity; it was shown that this was not due to the presence of aluminum hydroxide, but to the lower protein content of the adsorbed toxoid (10 mg % compared to 300-400 mb % in the crude toxoid). If, however, the purified toxoid did not contain a preservative (merthiolate) the antigenic properties remained unchanged even after irradiation, a fact which suggests a cumulative effect of radiation and antiseptics. Exposure of antitoxic sera to lower doses between 200000 and 6000000 r did not impair the titre but was sufficient to eliminate alien microflora. In some cases slight changes in the flocculation time occurred. At present the costs of the method are high. (OTS)

32685 THE ROLE OF PHYSICAL FACTORS IN THE BIOLOGICAL EFFECTIVENESS OF RADIOACTIVE ISOTOPES. Yu. I. Moskalev (Ministry of Health, USSR). Trudy Tashkent. Konf. po Mirnomu Ispol'zovan. At. Energ., Akad. Nauk Uzbek. S.S.R., 3: (1961).

The role of physical factors in the biological effectiveness of isotopes is reviewed. The biological effects of an isotope depend not only on the specific distribution in the organs but also on physical properties such as the energy, type of radiation, and half life. If the toxicity of an isotope is judged only on the basis of the effective dose expressed in curies, differences in the physical factors and rate of elimination from the body may lead to erroneous conclusions, as the biological effects depend not so much on the rate of disintegration as rather on the dose of radiation emitted in the tissues and on its microgeometrical distribution. The biological effects of soft β-rays, frequently higher than the effects of hard β-rays or even α-rays, chronic experiments concerning osteotropic isotopes (varying yield of bone tumors), and data concerning the importance of ionization density and concentration of the radiation are discussed. It is emphasized that physical factors must be taken into account in all attempts to assess the biological effectiveness of radioactive isotopes. (OTS)

32686 PROTECTIVE GLASSES AGAINST ATOMIC FLASH. James F. Culver and Albert V. Adler (USAF Aerospace Medical Center, Brooks Air Force Base, Texas). p.34-38 of "Visual Problems in Aviation Medicine." Armand Mercier, ed. Oxford, Pergamon Press, 1962.

Protective measures are discussed for the protection of the eyes against the flash that occurs with the release of immense energy at the time of a nuclear explosion. It is pointed out that much of this energy is released in the form of infrared, ultraviolet, and visible light. Light energy has been shown to be capable of producing an intraocular burn at distances in excess of hundreds of miles from a nuclear explosion. Emphasis is placed on the protection of aviation personnel from the flashblindness that results in the temporary inability to discriminate differences in contrast and a resulting lowering of visual acuity after exposure to an intense light of short duration. Various types of protective devices are discussed. A device made of photoreactive materials and actuator system to activate the photoreactive filters is described in detail. The entire system is designed

to be mounted on the standard Air Force and Navy helmet. Tests on prototype models of this interim device have shown it is one of the most promising devices against flashblindness developed to date. (C.H.)

32687 PHYSICOMATHEMATICAL ASPECTS OF BIOLOGY. Proceedings of the International School of Physics. "Enrico Fermi." Course XVI. Italian Physical Society. N. Rashevski, ed. New York, Academic Press, 1962. 530p. $16.00.

A series of lectures on Physicomathematical Aspects of Biology was presented during 1960 at the International School of Physics. Separate abstracts have been prepared on two selected items. Other lectures are included on general mathematical principles in biology, the physicomathematical foundations of reaction rate theory, enzyme reactions, sensory phenomena, unequal ventilation, cybernetic analysis of the respiratory chemostat, applications of pulmonary carbon dioxide diffusion in measurements of cardiac output in man, mathematical models for the representation of neural interaction, applications of neural net theory to psychological phenomena and problems of color vision, mathematical models for pharmacological systems, the role of diffusion in biological phenomena, and a mathematical pulsatile model of the human heart and applications in the analysis of indicator curves. (C.H.)

32688 NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,266,813. June 5, 1961.

In a gas-cooled reactor having a closed coolant circuit, fuel elements consist of a fuel member enclosed in a protective sheath and the coolant gas which reacts with the fuel members has minor proportions of a gas inert to the fuel members. Should a leak occur in the sheath of a fuel element, coolant gas enters the sheath, contacts the fuel member, and reacts in a progressively slower manner as the build-up of inert gas increases. A layer about the exposed fuel member is formed and prevents further reaction between the main coolant gas and fuel member. For example the carbon dioxide coolant of a reactor includes between 0.1 and 1.0% of helium by weight. (NPO)

Biochemistry, Nutrition, and Toxicology

32689 (TID-16458) ANNUAL PROGRESS REPORT [ON RADIOBIOLOGY]. (Utah. Univ., Salt Lake City. Radiobiology Lab.). Mar. 31, 1956. Contract AT(11-1)-119. 139p.

Data are presented from a series of long-term studies on the toxic effects of radioisotopes in dogs. Biological effects and radiological findings are summarized. Results are included from studies on the plasma concentration and excretion of injected Ra^{226}, the excretion of Ra^{224} and Th^{228}, Rn escape from bone containing Ra, the retention of Ra and Rn in beagles, measurements of exhaled thoron after the injection of Th^{228}, the plasma concentration of Sr^{90} at various times after injection, and a comparative study on the metabolism of Ca^{45} and Ra^{226} in dogs, with emphasis on deposition in old and new bone. (C.H.)

32690 (TID-16635) RADIOACTIVE ZINC-65 IN MARINE ORGANISMS IN FISHER'S ISLAND SOUND AND ITS ESTUARIES. Summary and Progress Report, December 1, 1961 through November 30, 1962. Donald M. Skauen (Connecticut. Univ., Noank. Marine Research Lab.). Aug. 25, 1962. Contract AT(30-1)-2487. 16p.

Data are tabulated on the total Zn and Zn^{65} content of oysters from the Thames River, New Haven harbor, and the Pawcatuck River, Connecticut. Levels of Zn, Cu, and Cd in several species of marine algae and marine molluscs were determined. The calorimetric methods of analysis used are described. (C.H.)

32691 (TID-16765) DOSIMETRIC ASPECTS OF RADIUM POISONING. Annual Report. Henry Petrow and Merril Eisenbud (New York Univ.–Bellevue Medical Center, New York. Inst. of Industrial Medicine). Aug. 31, 1962. Contract AT(30-1)-2896. 56p.

Progress is reported in studies of the skeletal radiation dose received by workers who engaged in painting dials with radium paints. The long-range objective is the correlation of data on dosage with pathological changes in the skeleton. Radiochemical separation procedures applicable to complex mixtures of Ra^{228}, Ra^{226}, and Ra^{224} were developed. A large number of paint samples were analyzed for Ra^{226} and Ra^{228} by gamma-ray spectroscopy. Equipment was built and calibrated for use in determinations of Rn in breath, air, and aqueous solutions. The equipment was used for the determination of Ra^{228} and breath Rn of 5 dial painters. Results of whole-body measurements for Ra^{226} and Ra^{228} in the same individuals gave results in reasonable agreement with the Rn breath measurements. Data are tabulated. Procedures were developed for the radiochemical analysis of Ra in bone tissue, and analysis of breath thoron as a possible means of determining the body burden of Ra^{228}. (C.H.)

32692 (TID-16796) THE TOXICITY OF RADIOSTRONTIUM. Miriam P. Finkel and Birute O. Biskis (Argonne National Lab., Ill.). July 1962. Contract [W-31-109-eng-38]. 39p. (UAC-6674)

Results are reviewed from studies on the effects of Sr^{90} on the life span and incidence of tumors in mice. Life shortening occurred after the injection of 44 μc/kg and lymphosarcoma occurred in greatest number and at earlier age after the injection of 88 μc/kg. A statistically significant increase in osteogenic sarcoma was not observed when less than 200 μc/kg was injected. (C.H.)

32693 (TID-16835) UPTAKE OF RADIOACTIVE MATERIALS FROM A NUCLEAR REACTOR BY SMALL MAMMALS AT THE NEVADA TEST SITE. Frederick B. Turner, Page Hayden, Jon H. Olafson, and Kermit H. Larson (California Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology). Sept. 1962. Contract AT(04-2)-Gen-12. 13p.

Because testing was suspended in October of 1958, it is assumed that there was no detectable thyroid radioiodine in mammals living on Jackass Flats, Nevada Test Site, in February, 1959, prior to the testing of a nuclear reactor designed to serve as a space rocket engine. This assumption is supported by the fact that after the reactor test on July 1, 1959, rabbits collected outside of the fall-out pattern showed no thyroid activity. However, slight thyroid activity (1.7 mμc/gm in rabbits, 0.20 to 3.25 mμc/gm in rodents) was detected within the fall-out pattern, to a distance of about 6 miles from the test site. This increment was attributable to the reactor test. Total beta activity of rodent skins increased 10-fold following the test, rabbit skins about 2.5 times. Rabbit gastrointestinal contents displayed a 15-fold increase in beta activity after the test, that of rodents increased 3.5 times. These increases were also attributable to the test. It is concluded that radioactive particles ingested from the fur contributed a large part of the thyroid radioiodine in kangaroo rats. On the other hand, thyroid radioiodine in jack rabbits was derived

largely from contaminated vegetation. Bone beta radioactivity was increased significantly in both rabbits and rodents because of the reactor test. Muscle radioactivity was increased significantly in rodents but not in rabbits. The radioactivity of kidneys, lungs, and livers showed no significant changes from February to July. This particular reactor test had no detectable deleterious influence on mammals living within the area investigated. (auth)

32694 (AEC-tr-5418) REGULARITIES IN STRONTIUM METABOLISM IN THE SKELETON AND MECHANISM OF STRONTIUM INCORPORATION INTO THE BONE SYSTEM. Albrecht Schmid. Translated by Lydia Venters (Argonne National Lab., Ill.) from Z. Physiol. Chem., 326: Nos. 5-6, 177(1961). 20p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, as abstract no. 20118.

32695 A MATHEMATICAL METHOD OF ESTIMATING THE PRODUCTION OF RED BLOOD CELLS BY REPEATED INJECTIONS OF RADIOACTIVITY. G. H. Jowett (Univ. of Melbourne). Biometrics, 18: 192-202(June 1962).

Evaluation of erythropoietic function by the use of radioactive labels is discussed in relation to the capture-recapture method for investigating changes in wild animal populations. Mathematical equations are derived and applied to experimental data. It is shown how estimates of the rate of creation at isolated instants may be made without actually fitting the differential equation for population growth, and without assuming the form of the mortality function of the cells. The methods proposed are based on the comparison of the value and gradient of radioactivity of samples of cells immediately before and after a number (possibly one) of successive injections, and minimize the number of injections necessary. (H.H.D.)

32696 THE PREPARATION AND PURIFICATION OF TRITIATED CARCINOGENIC HYDROCARBONS. Beppino C. Giovanella, C. W. Abell, and Charles Heidelberger (Univ. of Wisconsin, Madison). Cancer Research, 22: 925-30 (Sept. 1962).

Methods have been described for the preparation of tritiated carcinogenic polycylic aromatic hydrocarbons of high specific activity by the Wilzbach method. A large number of highly radioactive impurities were produced during exposure to tritium gas, and extensive purification was required. This was achieved by column chromatography followed by various paper chromatographic systems with some novel modifications. The following compounds were labeled by this method: 10-methyl-1,2-benzanthracene, 3-methyl-1,2-benzanthracene, 4-methyl-1,2-benzanthracene, 3-fluoro-10-methyl-1,2-benzanthracene, 4-fluoro-10-methyl-1,2-benzanthracene, 1,2,5,6-dibenzanthracene, 1,2,3,4-dibenzanthracene, 9,10-dimethyl-1,2,5,6-dibenzanthracene, 3,4-benzpyrene, 3-methylcholanthrene, 9,10-dimethyl-1,2-benzanthracene, anthanthrene, and 2-phenylphenanthrene-3, 2'-dialdehyde. (auth)

32697 METABOLISM OF IODINE (I^{131}) AND FORMATION OF IODINATED SCLEROPROTEIN (GORGONINE) OF THE CORNEOUS SKELETON OF EUNICELLA VERRUCOSA (PALLAS). J. Roche, S. André, and G. Salvatore (Collège de France, Finistère and Stazione Zoologica, Napoli, Italy). Comp. Biochem. Physiol., 1: 286-92(1960). (In French)

The presence of gorgonins containing up to 10% iodine in the corneous skeleton of sea-fans (gorgons) has long been known. The formation of iodinated amino acids in these proteins was studied with radioactive iodine (I^{131}). Gorgons (Eunicella verrucosa (Pallas), var. typica) immersed in seawater containing tracer-doses of NaI^{131} concentrate iodides with remarkable regularity. The efficiency of this process is such that in 15 days at 18°C nearly all the iodides present are fixed by the gorgons. Potassium thiocyanate inhibits this phenomenon reversibly, as in thyroid gland. Radiochromatographic analysis of the proteins of living tissues and of corneous skeleton shows that both contain labeled 3-monoiodo- and 3,5-diiodotyrosine. Formation of iodothyronines has not been observed. The synthesis of the two iodinated amino acids seems to take place only in living tissue secreting the precursors of gorgonins. The fibers of these do not seem to be halogenated later. The presence of iodotyrosines in gorgonins is probably not bound to an elementary thyroid function, even if these compounds are accompanied by traces of thyroxine and 3,5,3'-triiodothyronine, as shown in previous researches. The role of iodotyrosines of gorgonins seems to be only structural; they are probably permanent constituents of the protein fibers of the corneous skeleton. (auth)

32698 METABOLISM OF I^{131} AND THYROIDAL FUNCTION OF THE LARVAE (AMMOCOETE) OF A CYCLOSTOME PETROMYZON PLANERI BL. J. Roche, G. Salvatore, and I. Covelli (Université, Naples). Comp. Biochem. Physiol., 2: 90-9(1961). (In French)

I^{131} labeled iodides, added to immersion water, are fixed by larvae of Petromyzon planeri Bl. (Ammocoetes). The kinetics of binding and the distrivution of radioactivity in tissues of Ammocoetes were studied. I^{131} is concentrated preferentially in two organs, the endostyle and the dorsal-cord. Endocrine activity of the endostyle was studied by radio-chromatography and radio-electrophoresis of labeled iodinated compounds from the endostylar region as well as tissues receiving hormones. The endostylar region contains thyroid hormones, thyroxine and 3,5,3'-triiodothyronine, together with their precursors, 3,5-diiodotyrosine and 3-monoiodotyrosine. These iodinated aminoacids are incorporated into a protein from which they are liberated by enzymatic hydrolysis. No iodoprotein is present in non-endostylar tissues; almost all of the radioactivity is extractable by acid n-butanol. Receptive tissues contain only thyroxine and small amounts of 3,5,3'-triiodothyronine. The quantitative ratio of iodinated aminoacids, both in the endostyle and in peripheric tissues, is highly variable according to incubation time with labeled iodides. The biosynthesis of thyroid hormones by the endostyle of Ammocoetes seems to be not dissimilar to that of the thyroid gland of higher vertebrates but it is, however, rather slower. The hematic transport of the thyroid hormones is assured by a thyroxine binding protein. (auth)

32699 UPTAKE OF RUBIDIUM BY PLANTS FROM CATION-EXCHANGE RESIN SUSPENSIONS AND THEIR EQUILIBRIUM SOLUTIONS. Cornelis Herman Evert Werkhoven (Purdue Univ., Lafayette, Ind.). Dissertation Abstr., 23: 388(Aug. 1962).

An evaluation was made of rubidium absorption by plants from suspensions of a cation-exchange resin and their equilibrium solutions as affected by small distances, defined by high-porosity filters, separating the roots from the exchanger. At lower concentration and in absence of a filter, absorption from suspension by the tops after eight hours was twice as high as that from the solution. At higher concentration, absorption from the solution was higher than that from the suspension by about 50% after eight hours. However, absorption from the suspension was greater than from the solution after two- and four-hour periods. Absorption by the roots from suspension after eight hours without or with a filter was about twice as high as

from the solution, with one exception when the uptake from the suspension was only 10% higher than that from the solution. A 10-fold increase in the total amount of rubidium present in the system gave a 20-fold rise in the concentration of the equilibrium solution and a similar increase in the combined absorption from the solution and the suspension by the roots when filters were present. When the plants were grown in direct contact with the suspension and solution, the combined uptake at the higher concentration was only six times as high as that at the lower concentration. This indicated that contact absorption can best be shown in a system consisting of a highly saturated exchange surface in equilibrium with a solution of low concentration. The results indicate the existence of two-phase effects on ion absorption by plants. While equilibrium between a suspension and solution may appear to be complete, the data suggest that this is not so between living roots and colloids in a suspension. The lack of equilibrium in a small region between the colloids and the roots results in a replenishment effect, which makes itself felt as far as 150 μ away from the colloids.

32700 THE EFFECT OF NORETHANDROLONE ON EXPERIMENTAL DENTAL CARIES AND RADIO-PHOSPHORUS UPTAKE IN RAT MOLARS. Stanley Miner Shaw (Purdue Univ., Lafayette, Ind.). Dissertation Abstr., 23: 454-5(Aug. 1962).

The effect of Norethandrolone on the uptake of phosphorus in molar teeth in animals on high and low phosphorus caries-test diets was studied. The molar teeth were examined for smooth surface dental caries incidence, hemisectioned in a mesiodistal-sagittal plane, stained, and again examined for caries incidence. Norethandrolone-treated animals had a greater incidence of dental caries in molar teeth than respective control animals or animals on a diet supplemented with 2% Na_2HPO_4. The addition of 2% Na_2HPO_4 to the diet of treated animals decreased the caries incidence in molar teeth of the animals so that it approximated that of control rats fed a caries-test diet supplemented with 2% Na_2HPO_4. The addition of 2% Na_2HPO_4 to the basic caries-test diet reduced caries incidence in animals sustained on the diet, in comparison to animals fed basic diet only. Radiophosphorus levels in the molar teeth of Norethandrolone-treated animals fed a high phosphorus diet equaled the radiophosphorus levels in the animals on a high phosphorus diet alone. No statistically significant difference existed between the radiophosphorus content in the molar teeth of animals treated with Norethandrolone and respective control animals. No change in the effect of Norethandrolone on radiophosphorus uptake in molars of rats, with or without added phosphorus, over a time interval was shown. (P.C.H.)

32701 DEIODINATION OF THYROXINE-131 IN TUMOR-BEARING RATS. J. A. Stein (Hebrew Univ. Hadassah Medical School, Jerusalem), M. Anbar, S. Guttmann, and N. Ernst. Nature, 192: 1303-4(Dec. 1961). (IA-737)

The turnover of thyroxine in rats with non-metastatic myeloid leukemia tumor was investigated. The rate of deiodination of thyroxine was determined by administration of a tracer quantity of labeled thyroxine and measuring the amount of inorganic iodide formed by radioactive assay. To ensure complete retention of the iodide formed in the circulation, rats were surgically thyroidectomized 48 hr before the turnover experiment. Tracer thyroxine was injected into the vena cava following a bilateral nephrectomy. Blood samples were collected at 45 min intervals for 5 to 8 hr. The serum was separated and the iodine bound to protein and the total serum iodide were determined. It was found that the rate of deiodination was higher in animals bearing tumors than in the controls. The animals were killed and the specific activity of the tumors was compared with that of the gastrocnemius muscle. The specific activity of the tumors was 3 to 5 times higher than that found in muscle. (M.C.G.)

32702 TREATMENT FOR REMOVAL OF INHALED RADIOACTIVE CERIA ($^{144}CeO_2$) FROM THE LUNGS OF RATS. E. G. Tombropoulos and W. J. Bair (General Electric Co., Richland, Wash.). Nature, 196: 82-3(Oct. 6, 1962). (HW-SA-2692)

Diethylenetriamine pentaacetate (DTPA) removed approximately 90% of inhaled $Ce^{144}O_2$, in equilibrium with Pr^{144}, from the lungs of rats after exposure for 15 min to an aerosol generated from 0.3% suspension of $Ce^{144}O_2$. The rats were treated by 30-min exposures to aerosols produced from 25% DTPA. Results are compared with results obtained with phenylephrine hydrochloride, alone and with DTPA, and with Pleuronics-F68, a non-ionic dispersing agent. (C.H.)

32703 BALANCE OF POTASSIUM, RUBIDIUM AND CAESIUM BETWEEN JAPANESE PEOPLE AND DIET AND ASSESSMENTS OF THEIR BIOLOGICAL HALF-TIMES. Noboru Yamagata (Inst. of Public Health, Tokyo). Nature, 196: 83-4(Oct. 6, 1962).

The balance of K, Rb, and Cs between Japanese people and diet was determined from measurements on human soft tissues, muscles, and bones and analysis of the average diet of Japanese people. The biological half-time of K was calculated as 54 days, of Rb 140 days, and of Cs 76 days. Applications of the data in determining the levels of radionuclides of the alkali metals in man are discussed. (C.H.)

32704 DEPLETION OF CARBON-13 IN YOUNG KAURI TREE. H. S. Jansen (Inst. of Nuclear Sciences, Lower Hutt, N. Z.). Nature, 196: 84-5(Oct. 6, 1962).

Results are reported from measurements of the C^{13}/C^{12} ratio in a New Zealand kauri tree, Agathis australis, a thousand years old. Results are compared with measurements made on other old trees. The effects of tree height and conditions that prevailed in the area during the growth period on results are discussed. (C.H.)

32705 STUDIES OF THE BIOLOGICAL EFFECTS OF Ra^{226}, Pu^{239}, Ra^{228}($MsTh_1$), Th^{228}(RdTh), AND Sr^{90} IN ADULT BEAGLES. T. F. Dougherty, B. J. Stover, J. H. Dougherty, W. S. S. Jee, C. W. Mays, C. E. Rehfeld, W. R. Christensen, and H. C. Goldthorpe (Univ. of Utah Coll. of Medicine, Salt Lake City). Radiation Res., 17: 625-81(Oct. 1962).

The design of a long-term experiment to compare the biological effects of five radionuclides in adult beagles is presented. The goal is to obtain correlations between long-term biological effects and the radiation dose rates or some function thereof. The biological effects which are being studied and the accompanying dosimetric studies are described, and the methods which are being employed are summarized. A brief summary of the results of the first ten years of the long-term studies is presented. In general, the important biological end points observed in the dogs are quite comparable to those observed in human beings exposed to Ra^{226} and Ra^{228}. A more quantitative comparison, in terms of times required for onset of effect and radiation doses to produce an effect, has not been made because of the incompleteness of the studies presented. Many dogs are still living, and some have not yet been rejected. It is anticipated that the forthcoming results of these studies will provide a firmer scientific basis for the estimation of maximum permissible levels of these radionuclides as in-

dustrial hazards. Since study and evaluation of effects of long-term internal irradiation in the dog require a large control dog population as a frame of reference, these studies will also provide a detailed picture of aging in the dog. (auth)

32706 THE EFFECTS OF COMPLEXONES ON THE BEHAVIOR OF METALS AND RADIOACTIVE AGENTS IN THE BODY. III. Phosphates. I. P. Tregubenko and D. I. Semenov. Trudy Inst. Biol., Akad. Nauk S.S.S.R., Ural' Filial, 12: 5-22(1960).

Investigations were made to give the results of research carried out with complexones of the phosphate group to find the most effective and, at the same time, the least toxic complexones of the phosphate group and to determine the general pattern of their action on the behavior of radioactive agents in the body. The tests were carried out on white rats. Polyphosphates and metaphosphates (sodium pyrophosphate, sodium tripolyphosphate, sodium hexametaphosphate, sodium tetrametaphosphate, sodium trimetaphosphate, and sodium orthophosphate) were administered to the rats parenterally before, during, or soon after incorporation of radioactive agents (strontium, yttrium, lead, plutonium) in indicator quantities. The excretion of the radioactive agent with the urine and the stools was recorded and a dynamic study made of the radioactivity content of the liver, kidneys, skeleton, spleen, and carcass. It was found that administration of the poly- and metaphosphates led to a marked drop in deposition of the radioactive agent in the skeleton, increased its excretion with the urine, and intensified its deposition in the parenchymatous organs. The lower the dose of phosphate administered, the less the effect on the deposition of radioactive agent in the skeleton and excretion of the agent with the urine, but the more marked the increase in deposition of the radioactive agent in the soft organs. The lower the fraction of radioactive agent in the blood when the phosphate was injected, the less marked was the phosphate's effect on the agent's deposition in the organs and its excretion with the urine. In relation to most of the radioactive isotopes tested, phosphates proved less effective than EDTA. In contrast to the latter, however, they increased the excretion of radioactive strontium from the skeleton. It was concluded that trimetaphosphate, because of its low toxicity, lack of noticeable decomposition in the body and its ability to eluate radioactive strontium from the bone tissue, may have a possible clinical application. (OTS)

32707 ON THE RETENTION OF AIR-BORNE PARTICLES IN THE HUMAN RESPIRATORY TRACT. H. D. Landahl (Univ. of Chicago). p.348-53 of "Physicomathematical Aspects of Biology." New York, Academic Press, 1962.

Methods are described for use in calculations of the probability of inhaled radioactive particles being retained in any part of the respiratory tree through contact with the surface membranes. The effects of impaction, settling, diffusion, size of particle, density, shape, rate, and pattern of breathing are considered. A numerical description of the bronchial tree and various tidal air volumes and respiratory patterns were used for calculating the retention probability for various segments of the bronchial tree. Data are presented graphically. (C.H.)

32708 RADIOISOTOPES IN SOIL-PLANT NUTRITION STUDIES. Proceedings of the Symposium held in Bombay, 26 February–2 March 1962. (International Atomic Energy Agency, Vienna). Proceedings Series. June 1962. 469p. (STI/PUB/55). $9.00; 189s.; NP 36; DM 31.50(IAEA).

A symposium on Radioisotopes in Soil-Plant Nutrition Studies was held at Bombay, Feb. 26 to March 2, 1962. Separate abstracts were prepared for 8 papers; abstracts of 2 papers have appeared previously in NSA. Other papers presented covered various aspects of soil chemistry, soil physics, ion uptake and translocation in soils, biological measurement of soil characteristics, and fertilizer usage. (C.H.)

32709 ON THE RADIOACTIVITY OF PLANTS FROM THE HIGH RADIATION AREAS OF THE KERALA COAST AND ADJOINING REGIONS. I. STUDIES ON THE UPTAKE OF GAMMA-EMITTING RADIONUCLIDES. A. R. Gopal-Ayengar and K. B. Mistry (Atomic Energy Establishment, Trombay, India). p.3-16 of "Radioisotopes in Soil-Plant Nutrition Studies." Vienna, International Atomic Energy Agency, 1962. (In English)

The radioactivity in plants growing on the monazite deposits occurring along the west coast of Kerala State and parts of Madras State in South India was measured. Gamma-ray scintillation spectrometry, using a sodium iodide–thallium-activated crystal and a multichannel pulse height-analyzer, was carried out over a range from 0 to 3.0 Mev on samples of the following species: Cocos nucifera, Spinifex squarrosus, Ipomoea biloba, Calotropis gigantea, Lochnera rosea, Thespesia populnea, Pandannus tectorius, Azadirachta indica, Phyllum nodiflora, Eupatorium urticaefolium, Pedalium Murex, Euphorbia sp., Phyllantus sp. and Fimbristylis sp., collected from the high radiation areas. Measurements were also made on control samples of representative species. The individual radionuclide contents of the following gamma-emitting members of the thorium series are reported: radiothorium (thorium-228), thorium X (radium-224), mesothorium 2 (actinium-228), thorium C (bismuth-212) and thorium C'' (thallium-208). This investigation clearly establishes the uptake of the radionuclides of the thorium series by plants growing on monazite-bearing soils. The differences between the radionuclide contents of the various plant species are discussed in view of the fact that the members of the thorium series are radioisotopes of different chemical elements. The significance of the differences between the uptake of radionuclides has been suggested in the light of the present knowledge regarding the mechanism of the entry of elements into plants through the roots. The possibility of the foliar absorption of the gaseous emanation thoron and its decay products, which include thorium C and thorium C'', is also considered. For coco-nut, an interesting observation is the relatively greater accumulation of these radionuclides in the kernel of younger trees. The magnitude of the internal dose in the plant body is a function of such determinants as the number of quanta given off by the source radionuclei, the energy relationships of these quanta, and the extent to which the structural elements surrounding the source absorb or scatter the radiations. The distribution of the radioisotopes between leaf and stem, and between shoots and roots, for some of the plant species for which such data are available, is discussed, and the need for further work on translocation patterns is stressed. An elucidation of the reported data as an indication of the contamination of biological material, more specifically, food chains and related biosystems, by natural radioactive elements is presented. It is realized that more information is required on discrimination factors, retention times, and other parameters to assess the extent of hazard presented by such contamination. (auth)

32710 CATION EXCHANGE PHENOMENA AS AFFECTED BY THE SOIL MOISTURE CONTENT. I. CATION EXCHANGE CAPACITY. R. Mokady, I. Shainberg, J. Hagin, and E. Bresler (National and University Inst. of Agriculture,

Rehovoth, Israel). p.31-41 of "Radioisotopes in Soil-Plant Nutrition Studies." Vienna, International Atomic Energy Agency, 1962. (In English)

An experimental system for the study of cation exchange processes in unsaturated soil is described, which is suitable for the moisture content range from field capacity to saturation. The cation exchange capacity (CEC) values were determined, using 0.01 N solutions of NaCl and RbCl, or mixtures thereof, labeled with Na^{22} and/or Rb^{86}. A simple procedure for the estimation of the CEC at any unsaturated condition from the data of the CEC at saturation and the soil moisture retention curve, is presented. The effective CEC was determined by the soil moisture content. The value of the CEC was affected by the cation present in the dilute solutions used in the experiments. The results showed that the effective CEC of the soil tested was greater for Rb than for Na. (auth)

32711 DETERMINATION OF P^{32} EXCHANGEABLE PHOSPHORUS IN SOILS. Fathi Amer (Univ. of Alexandria, U.A.R.). p.43-58 of "Radioisotopes in Soil-Plant Nutrition Studies." Vienna, International Atomic Energy Agency, 1962. (In English)

The accuracy of measurements of exchangeable phosphorus for soils which differ in their phosphate-fixing capacity was investigated. After equilibrating the soil with tagged solutions, P^{32} recovery was measured by the resin adsorption method and the specific activity of phosphorus on the resin was compared with that of the equilibrium soil extract. In some soils, the specific activity of phosphorus on the resin was higher than that in the equilibrium solution. This indicated that during the equilibration period, some P^{32} was taken up by the soil in a form which was no longer exchangeable with phosphorus in solution. The appearance of non-exchangeable P^{32} during extraction increased with the phosphate fixing capacity of the soil, and led to over-estimation of exchangeable phosphorus, especially in the carrier-free method. The addition of carrier phosphorus tended to reduce the error due to non-exchangeable P^{32}. A method that involved equilibrating the soil with 100 ml of 0.2 ppm phosphorus solution was recommended and proved satisfactory for determining exchangeable phosphorus in low- and medium-fixing soils. The equilibration period was limited to 30 min to reduce the effect of recrystallization and self-diffusion and to avoid any changes that may take place in the soil system during long equilibration periods. Exchangeable-phosphorus results were interpreted as a measure of the specific surface of the phosphorus compounds present in the soil, in addition to any phosphorus that may be present in the absorbed form. It was suggested that a simple relationship between water soluble and exchangeable phosphorus may not exist. Solubility in the soil solution is determined by the most soluble compounds and the smallest size particles, whereas exchangeable phosphorus is a measure of all phosphorus compounds and all size particles. (auth)

32712 KINETICS OF ISOTOPIC EXCHANGE BETWEEN SOIL PHOSPHATES, SOIL SOLUTION AND PLANT. B. Ulrich, H. Lin, and H. Karapurkar (Universität, Goettingen). p.59-74 of "Radioisotopes in Soil-Plant Nutrition Studies." Vienna, International Atomic Energy Agency, 1962. (In English)

The use of radioisotopes in soil fertility studies has been mainly concerned with the determination of the amounts of nutrients in the soil, on the one hand isotopically soluble, and on the other isotopically exchangeable. In other words, determination has been made of the amount of ions in the solid-soil phase which takes part in the turnover with the soil solution. There is often a correlation between this amount and the soil-fertility status, but it has been shown that there is no causal connection between the amount of isotopically-exchangeable nutrients and the amount of plant-available nutrients in the soil. By measuring the amounts of isotopically-exchangeable nutrients, labeled with P^{31} and P^{32}, as a function of reaction time in the state of chemical equilibrium, the authors obtained a measure of turnover rates of nutrients between the solid-soil phase and the soil solution in the state of chemical equilibrium. Supposing that the isotope exchange corresponds to a series of first-order reactions, which vary by a factor of five or more in reaction half times, it is possible to use the graphical and mathematical treatment of isotope exchange isotherms as developed by Scheffer et al. The resolution of the isotope exchange isotherms yields: the number i of first-order reactions, which are involved in isotope exchange; the amount of phosphate ions in the solid phase, which take part in each of the various reactions, called a_i and expressed in mg P/g solid phase (phosphate versus soil); and the exchange constant of the various reactions, called R_i^*, with the dimension t^{-1} (e.g. min^{-1}). By multiplication of the exchange constant R_i^* with the respective amount or concentration a_i the reaction rate R_i is obtained. Some results have already been published and others will follow. Having thus obtained a complete description of the processes in chemical equilibrium, the question arises as to whether these results can be used for the prediction of reaction rates in chemical unequilibrium, e.g. for the prediction of solubility rates. This is especially important for soils because we cannot measure solubility rates of soil components at solid/solution ratios corresponding to the water content of soils under field conditions. Some approaches to this aim are presented. (auth)

32713 SOIL PROPERTIES AND CONSTITUENTS IN RELATION TO MECHANISMS OF SULPHATE ADSORPTION. M. E. Harward, T. T. Chao, and S. C. Fang (Oregon State Univ., Corvallis). p.93-114 of "Radioisotopes in Soil-Plant Nutrition Studies." Vienna, International Atomic Energy Agency, 1962. (In English)

Studies were conducted by the use of soil column-chromatographic techniques, adsorption-desorption phenomena, and isotopic exchange procedures in order to delineate cause and effect relationships involved in the retention of sulfate by soils. The distribution patterns of S^{35} in soil columns were found to be dependent on soil characteristics and the amounts of water applied, but were independent of the amounts of sulfate applied. Samples of Latosols, Lateritic, and Ando soils showed distinct abilities to hold sulfate against leaching. The results of adsorption-desorption equilibrium studies were in good agreement with the column studies. Both indicated that sulfate retention is dependent on the concentration of the equilibrium solution. Adsorption isotherms conformed to the Freundlich type and adsorption maxima were not indicated. Although certain soils were shown to have a marked capacity to retain sulfate, the sulfate could be easily desorbed. The treatments of sulfate-retentive soils for the removal of organic matter, free iron, and free aluminum all resulted in marked reductions in sulfate retention. The amounts of sulfate retained by reference clays were in the order kaolinite > illite > montmorillonite. Al-saturated clays retained more sulfate than H-saturated clays. Sulfate adsorption generally increased as the degree of neutralization and pH of an Al-saturated resin increased, whereas sulfate adsorption decreased with increasing pH of Al-saturated bentonite. The data suggest that two factors,

the formation of reactive OH anion-exchange sites and the effect of pH on amphoteric properties of reactive groups, were operative in these systems. Sulfate adsorption by soils from salt solutions and by soils saturated with different cations followed the order of chemical valency of cations. The influence of different cations was shown to be associated with two factors, the nature of cations and pH. Resolution of the two factors indicated that pH had the more significant influence. The influence of different cations was attributed to effects on electrokinetic potentials and anion repulsion. The evidence indicates that sulfate retention by soils may involve several mechanisms including: anion exchange involving hydrous oxides of Fe and Al and crystal edges of clays at low pH's; the retention of sulfate by co-ordination with hydroxy-aluminum complexes; salt or molecular adsorption resulting from attraction between the surface of soil colloids and the salt; or retention by amphoteric organic compounds. (auth)

32714 THE INFLUENCE OF CONCENTRATION ON THE UPTAKE OF LABELLED RUBIDIUM BY EXCISED BARLEY ROOTS. Myriam Vallée Shealtiel (Faculté des Sciences, Paris). p.239-48 of "Radioisotopes in Soil-Plant Nutrition Studies." Vienna, International Atomic Energy Agency, 1962. (In French)

The results so far obtained in regard to the uptake in relation to concentration of labeled rubidium by excised barley roots are incompatible with a theory of absorption kinetics based on the hypothesis of a simple enzyme reaction. A theory which postulates two distinct absorption reactions of the type described by Michaelis-Menten kinetics might possibly explain certain results, but not all. It appears that absorption must consist of several reactions. This hypothesis is developed on the basis of the work of other research workers, and the conclusion is that the absorption-concentration relationship depends on many factors: external (especially the presence in the absorption environment of ions other than the one under study) and internal (the physiological state of the absorbing material). It is not possible to describe the absorption process in terms of a rigid system. (auth)

32715 SOME USES OF RADIOISOTOPES IN MICRONUTRIENT PLANT STUDIES AT UTAH STATE UNIVERSITY. R. L. Smith, H. H. Wiebe, and N. G. Perur (Utah State Univ., Logan). p.249-58 of "Radioisotopes in Soil-Plant Nutrition Studies." Vienna, International Atomic Energy Agency, 1962. (In English)

The author describes several experiments in which Fe^{59} or P^{32} were used in the study of lime-induced chlorosis. When Fe^{59} was applied to the plant leaf, and the factors believed to induce chlorosis, that is, the bicarbonate level, high pH, or high phosphorus, were varied in the root solution media, the iron appeared to be inactivated in the translocating portion of the plant. This inactivation was thought to be in the phloem. The iron was separated from the phosphorus, but both elements were taken up by the root by using a split-root technique. The interaction of the phosphorous and iron, which could occur only within the plant, was not strongly evident. If bicarbonate was present in the root media with the iron there was a reduction in the amount of iron moving into the leaves, but when bicarbonate was present with the phosphorus there was no reduced iron uptake. Corn plants were grown under conditions of simple iron deficiency and then fractionated by differential centrifugation. The activities of catalase, peroxidase, dehydrogenase, and cytochrome oxidase were reduced by 83%, 53%, 55%, and 25% respectively in the case of iron-deficient plants. Those plants which had not received iron previously showed a greater uptake of Fe^{59} over a period of 24 hr. There was still a reduced uptake of Fe^{59} in the chloroplast fraction of the chlorotic plants which followed the pattern of total iron analysis. A preliminary report is given on the problem of organic matter, added to a soil and allowed to decompose, inducing zinc deficiency in a subsequent bean crop. Fractionation of the soil indicated added Zn^{65} increase in the organic fraction as the amount of organic matter increased. The carbonate fraction also showed an increase in Zn^{65}. (auth)

32716 THE LOSS OF ORGANIC AND INORGANIC MATERIALS BY LEACHING FROM LEAVES AND OTHER ABOVE-GROUND PLANT PARTS. H. B. Tukey, Jr. (Cornell Univ., Ithaca, N. Y.). p.289-302 of "Radioisotopes in Soil-Plant Nutrition Studies." Vienna, International Atomic Energy Agency, 1962. (In English)

Despite numerous reports over more than a century that leaves can absorb water and nutrients, the classical concept has persisted that the leaf is an appendage concerned with food manufacture, separated from the external environment by an impermeable cuticle, broken only by stomata which allow the passage of gaseous materials. More recently it has been clearly demonstrated by the use of radioisotopes that above-ground plant parts, including leaves, stems, and fruits, are able to absorb nutrients applied to them. It naturally follows, and has been so demonstrated by the use of radioisotopes, that above-ground plant parts may also lose materials by the leaching action of aqueous solutions. All plants which have been studied, including 16 representative cultivated species, have been leached by aqueous solutions to some degree at least. Substances which have been leached include both organic and inorganic forms. Inorganic materials have been classified according to ease of leaching, as easily leached such as, Na^{24} and Mn^{54}, moderately leached such as, Ca^{42}, Mg^{28}, S^{35}, K^{42}, and Rb^{86}; and leached with difficulty such as Fe^{52-59}, Zn^{65}, P^{32}, and Cl^{36}. Organic materials so far identified include several free sugars and sugar alcohols, 16 amino acids, several organic acids (Krebs' cycle), and various pectinaceous compounds. Pathways of loss have been demonstrated as involving hydathodes, plasmodesmata and ectodesmata, proteinaceous areas lying near the termination of vascular strands, continuous arrangements of cell walls, breaks in the cuticle, absence of cuticle, and penetration of the cuticle itself. Materials which have been leached from leaves may be absorbed by roots of the same or another plant, indicating a system of recycling from leaf to soil medium and back into the plant through the root. For example, Sr^{90} applied to the leaves of potato plants (Solanum tuberosum) is unable to move into other plant parts from the point of application, but it may be leached from the leaves by rain or mist, taken up by the roots, and accumulated in the tubers. Leaching from above-ground plant parts may have an appreciable effect on soil formation, on the alteration and maintenance of soil fertility, and on plant ecological association and distribution. The concept of leaching re-emphasizes the importance of leaves as organs concerned with processes which are additional to the major role of photosynthesis. (auth)

Fallout and Ecology

Refer also to abstract 33284.

32717 (AEC-tr-5381) BARRIER AND FILTER EFFECT OF VEGETATION WITH RESPECT TO VOLATILE

RADIOIODINE. Walter Herbst. Translated by L. L. Smith (Savannah River Lab., E. I. du Pont de Nemours & Co., Aiken, S. C.), from Strahlentherapie, 116: 420-5 (Nov. 1961). 7p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, as abstract no. 8474.

32718 THE BERYLLIUM-7 CONCENTRATION IN THE ATMOSPHERE ABOVE THE ATLANTIC OCEAN. V. N. Lavrenchik, L. N. Samoilov, P. M. Chulkov, and V. F. Gorbunov. At. Energ. (USSR), 13: 25-30(July 1962). (In Russian)

The Be^7 isotope is formed in the atmosphere by the interaction of neutrons and protons of cosmic origin with the N and O of the atmosphere. The average rate of formation was calculated at 2.4×10^4 atoms/cm^2. The geographic distribution of this isotope was measured during the period from March to July 1961 by means of an apparatus carried by the research ship "Mikhail Lomonosov." The air filter system used had a capacity of about 3000 m^3/hour. After pulling the air through, the filter was burned and the ashes were subjected to γ-spectroscopic or radiochemical analysis. Measurements were made in the geographic range from 48° North to 30° South latitudes in the Atlantic. Results indicated a maximum of the Be^7 activity at about 27° North and South and a minimum near the equator. Comparison of the results obtained with those reported by R. List and R. Telegadas (LASL-111, 1961) indicates that the measured values represent total Be^7 in both the troposphere and the stratosphere. The data agree well with N. Anderson's previously reported values (Nature, 187: 4737 (1960)) who found concentrations of about 5 atoms per liter of air. (TTT)

32719 THE DISTRIBUTION OF CERIUM-144 AND RUTHENIUM-106 ABOVE THE ATLANTIC OCEAN. V. N. Lavrenchik. At. Energ. (USSR), 13: 72-3(July 1962). (In Russian)

The oceanographic research ship Ob' which left Kaliningrad in November 1958 carried an air filtering apparatus with a capacity of 250 m^3/hour; this apparatus was used for collecting samples of radioactive dust during the cruise. The activity of the dust was determined, after combustion of the filters, by means of a scintillation γ-spectrograph provided with a flat NaI(Tl) crystal for determining the 661-kev quanta. During the measurements carried out in June 1959 lines corresponding to Zr^{95}, Nb^{95}, Rh^{106}, Ce^{144}, Cs^{137}, Co^{141}, and Ru^{103} were observed. Repeated analysis of the same samples at the end of 1960 indicated the presence of Cs^{137}, Ru^{106}, and Ce^{144}. The activities of the latter two elements were quantitatively determined by counting the Compton electron pulses superimposed on photoelectron pulses with an error of less than 20%. Distribution of the concentration presents a minimum at the equator, possibly due to the rise of heated air masses. Radioactive contaminations near the equator may be due to tropospheric transfers. The highest concentrations were found at latitudes of 30°N and 15°S. The data do not agree completely with results obtained during the 1959 cruises of the research ship Vityaz in the Pacific and Atlantic Oceans. This might be due to the fact during 1959 only stratospheric fallout was observed while in 1958 the tropospheric fallout was also quite noticeable. Deposits north of 40° were mostly old. (TTT)

32720 REPORT OF THE NATIONAL ACADEMY OF SCIENCES SUBCOMMITTEE FOR THE ASSESSMENT OF DAMAGE TO LIVESTOCK FROM RADIOACTIVE FALLOUT. John H. Rust (Univ. of Chicago). J. Am. Vet. Med. Assoc., 140: 231-5(Feb. 1, 1962).

It was concluded that flesh from moribund animals exposed to large doses of β and γ radiation may be safely eaten. It is likely that external γ-ray exposure will result in death of farm animals before injury to the gastrointestinal tract from consumption of fission products becomes a critical factor. Exposure to heavily contaminated forage for prolonged periods may result in loss of milk or egg production without causing death of the animals. Radioactive Sr, Cs, and I consumed by animals would not cause death of the animals or serious radiation injury, but, when combined with external γ-ray exposure, might augment internal damage and the death rate expected from the external radiation. Fertility of livestock probably would not be greatly affected by external γ-ray exposure, contrary to experimental results in small laboratory animals, and no matter how high the exposure, reduction of fertility to the point of wiping out livestock populations would not be expected. (H.H.D.)

32721 UMWELTRADIOAKTIVITAT UND STRAHLENBELASTUNG. Bericht IV/61. (Environmental Radioactivity and Radiation Burden. Report IV/61). Bad Godesberg, Ger., Bundesminister für Atomkernenergie, 1961. 8.00 DM.

A report is presented on the content of radioactive materials in air, water, soil, and food and on the radiation burden of the population of the Federal Republic of Germany. Surveillance of radiation in the air and environment, in surface water and waste water, in drinking water, in sea water, in soil, and in food chains is discussed. Surveillance of fallout and radiation in precipitation is also considered. The content of radioactive material in the human body was investigated. Results are presented in tables and graphs. (M.C.G.)

Radiation Effects on Living Tissues

32722 (AERE-R-4112) A SURVEY OF BLOOD COUNT DATA FROM NEW ENTRANTS BETWEEN THE YEARS 1949 AND 1960. F. M. Turner (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). July 1962. 21p.

A survey was made of hemoglobin and white cell count levels based on the data from hematological investigations made on new employees between the years 1949 and 1960. The data were analyzed according to age, sex, and season of the year and the results were compared with those of other workers. It is suggested that the normal range for the neutrophil count should be extended from 2500 to 7500 to 2000 to 7500 cells per cmm. (auth)

32723 (AF-SAM-62-67) RADIOBIOLOGIC EXPERIMENTS IN DISCOVERER SATELLITE XVII. George W. Crawford, ed. (School of Aerospace Medicine, Brooks AFB, Tex.). June 1962. 50p.

On Nov. 12, 1960, Discoverer XVII satellite was placed on a polar orbit having a perigee of 103.1 nautical miles near 17° latitude north and an apagee of 538 nautical miles near 20° latitude south. The orbital period was 96.44 min. Biological specimens were mounted in the nose cone for exposure in studies of the biologic effects of cosmic radiations at the cellular level and to correlate the observed biologic effects with the types and intensities of measured cosmic radiations. The biopack cans contained cultures of human conjuctival cells and human synovial cells, spores of Clostridium sporogenes, ampuls containing algae, human serum gamma globulin, rabbit antiserum specific for human gamma globulin, three types of chemical dosimeters,

packages of alanine, packages of albumin, silver-activated phosphate glass rods, stacks of neutron-sensitive film, step-plate packages of Dupont 552 film sets, nuclear track plates, and antimony foil. The radiation environment encountered on the flight included galactic, trapped, and solar cosmic rays. The satellite was on orbit during the second surge of a 3^+ magnitude solar flare. The dosimeters are described and the identification of particles and dose measurements are discussed. Since no positive identification was made of the radiation encountered during the Discoverer XVII rocket flight, the response of the detectors flown on this flight are reported in terms of rad equivalent of 730-Mev protons. Data are reported on the biological condition of the exposed specimens. Comparisons were made with control specimens. On the basis of the data obtained, it was concluded that the photosynthetic organisms are capable of living and retaining viability in actual space environments, that the algae Chlorella ellipsoidae could survive and function as a part of a life-support system when exposed to radiation levels for the orbital time period of the Discoverer XVII satellite, and that none of a number of physiologic responses evaluated were detectably harmed by exposure to the environment encountered. (C.H.)

32724 (BNL-6229) PLATELET-ENDOTHELIAL INTERACTIONS AS STUDIED BY THE ELECTRON MICROSCOPE. H. Cottier and E. P. Cronkite (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract [AT(30-2)-Gen-16]. 17p.

Platelet adhesion to the vessel wall and primary thrombus formation was examined by electron microscopy in the anterior pituitary gland of rats given local x irradiation with 8000 r, 24 hours prior to sacrifice. On repeated sectioning, most platelet aggregates or primary mural thrombi showed at least one area where the thrombocytes were attached to the denuded basement membrane. The implications of this finding and the possible mechanisms involved in platelet-endothelial adhesion are discussed. (auth)

32725 (HW-SA-2638) KINETICS OF RADIATION-INDUCED HEMOLYSIS OF HUMAN RED BLOOD CELLS. R. W. Henkens and D. R. Kalkwarf (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [June 11, 1962]. Contract [AT(45-1)-1350]. 10p.

The rate of hemolysis of red blood cells in aqueous suspension by γ radiation was found to be dependent on absorbed dose. Red blood cells thus provide a relatively simple biological system for studying the efficiency of chemical compounds as radiation protective agents. Data are presented from measurements of the kinetics of radioinduced hemolysis of human red blood cells suspended in isotonic saline. An exponential relationship was found between absorbed dose and the time required for half the cells to hemolyze. It is postulated that the damage to the cell that ultimately results in hemolysis is caused by free radicals, that a cell can undergo numerous reactions with the radicals giving rise to a cell that is visibly unchanged but chemically modified, that all the reactions between radical and cell are bimolecular with equal rate constants, and that the time it takes a cell to hemolyze is a function of the number of reactions it has undergone. A formula is presented for calculating the reactions between radicals and cells, and analogous reactions can be written for each of the added chemical substances. Data are presented on the effects of valine, histidine, tryptophan, and erioglaucine on hemolysis of red blood cells at various times after irradiation. Results show that the addition of a protective agent will afford protection from radioinduced hemolysis. (C.H.)

32726 (NP-12089) MOUSE CARCINOGENICITY STUDY. Progress Report, March 1, 1957–March 15, 1962. J. L. Radomski and William B. Deichmann (Miami, Fla. Univ., Coral Gables. School of Medicine). Contract DA-49-007-MD-789. 10p.

No indications of a significant increase in tumor incidence that could be ascribed to diet were observed in mice maintained on a diet consisting of a mixture of irradiated beef, tuna, corn, sweet potato, and fruit compote, supplemented by the addition of vitamins. Data are tabulated on gross pathology, average weights, average food consumption, and survival. (C.H.)

32727 (NP-12127) BIOLOGICAL EFFECTS OF NON-IONIZING RADIATION ON HUMANS AND HIGHER ANIMALS. Selected References in English, 1916–1959. Richard S. Cutter, comp. (National Library of Medicine, Washington, D. C.). Apr. 1960. 18p.

Selected references are presented from the literature from 1916 through 1959 on the biological effects of non-ionizing radiation on humans and higher animals. (C.H.)

32728 (TID-16732) CHARACTERISTICS OF MAMMALIAN CELL POPULATIONS SURVIVING HIGH DOSES OF X IRRADIATION IN VITRO. Warren K. Sinclair (Argonne National Lab., Ill.). June 1962. Contract [W-31-109-eng-38]. 24p. (UAC-6543)

Colonies of Chinese hamster lung cells grown in tissue culture surviving 1500 r of 250 kvp x rays showed a broad size spectrum which was shown to be due to the variable growth rate of the colonies. The properties of large and small colonies were compared after isolation and subcultivation. Large colonies gave rise to fast growing populations of high plating efficiency which had the same radiosensitivity as the parent unirradiated cells. Small colonies of 50 cells or more at 12 to 14 days, but not later, were viable and gave rise to sublines which had slow growth rates, poor plating efficiency, and increased radiosensitivity. The chromosome number spectrum was broadened for all surviving colonies, severely in many cases to modal tetraploid numbers. Neither this, nor the high frequency of chromosome aberrations appeared to be involved in the radiosensitivity of the survivors. (auth)

32729 (TID-16735) RADIATION-INDUCED CHROMOSOMAL ABERRATIONS AND VARIANT CLONES IN MAMMALIAN CELLS CULTIVATED IN VITRO. Agnes N. Stroud, Austin M. Brues, and Beverly M. Svoboda (Argonne National Lab., Ill.). June 1962. Contract [W-31-109-eng-38]. 28p. (UAC-6566)

A culture of diploid pig kidney cells (37 chromosomes) was irradiated with various x ray dosages. The estimated D_0 of this line is 180 rads. Examination of chromosome aberrations 24, 27, and 30 hours after irradiation shows that their frequency increases not only with dose but with time after irradiation, this is most marked after the higher doses, so that a theoretical dose-effect relation is approached only after 30 hours. At this time, 200 r produces an average of more than one break per cell, and 500 r two or more breaks per cell. Clones started one month after irradiation and kept under cultivation for 8 or 9 months have variously reduced growth rates, persisting chromosome aberrations, and various alterations in the pattern of thymidine uptake. The growth rates of these clones were inversely related to the frequency of aberrations. When the stem line was reirradiated after 9 months cultivation it showed the same temporary retardation of growth as it did originally. Reirradiation of 4 of the 5 surviving clones showed a reduction in growth rate that was of longer dura-

tion, and more marked in the slower growing ones. The aberrations in the clones, which persisted after several months, were predominantly chromatid breaks, and in many cases the same break was seen repeatedly at a particular site on the chromatid. (26 references.) (auth)

32730 (TID-16742) EVIDENCE SUGGESTING PROTECTION AGAINST "DIRECT" ACTION OF X-RAYS IN THE BACTERIAL SPORE. R. B. Webb and E. L. Powers (Argonne National Lab., Ill.). June 1962. Contract [W-31-109-eng-38]. 17p. (UAC-6499)

Three kinds of radiation damage may be clearly defined in near-dry spores of Bacillus megaterium. The first is oxygen-independent, water-dependent, and temperature-dependent; the second depends upon the presence of oxygen during irradiation, and is water-dependent; and the third includes damage brought about by the induction of radicals by the radiation and their subsequent reaction with oxygen. Results are reported from a study on the effect of glycerol addition to the spore on these various components of radiation damage. It was concluded that the presence of high concentrations of glycerol offers effective protection against radiation in bacterial spores. The data indicate a physical rather than a chemical mechanism for the protective action. (C.H.)

32731 (TID-16763) X-RADIATION RESPONSE OF AUXIN FORMATION BY ANIMAL TISSUE. S. A. Gordon and E. Buess (Argonne National Lab., Ill.). June 1962. Contract [W-31-109-eng-38]. 20p. (UAC-6590)

The radiosensitivity of auxin formation was studied in a number of animals after exposure to 200 r/min x radiation. Data are presented on the activity of the tryptophan-indoleacetate enzyme system and free acid-auxin levels in various organs of the dog, and enzyme and free acid-auxin activities in the liver of 17 young adult animals, in the kidney of 4 animals, and in the testis of 4 animals. Results indicate that the tryptophan-indoleacetic enzyme system in animals does not involve tryptophan pyrrolase. Some evidence was seen that the pathway between tryptophan and auxin does not involve the 5-OH (seratonin) route, though some auxin activity was resolved from indoleactic acid by the chromatographic technique employed. The enzyme system that converts tryptophan to indoleacetate, as well as auxin, was found in a number of animal organs. No correlation between free auxin and enzyme was found. (C.H.)

32732 (TID-16776) RATE OF RECOVERY FROM RADIATION INJURY AND ITS RELATIONSHIP TO AFTER-EXPECTATION OF LIFE IN MICE. Progress Report, January 1, 1962–September 7, 1962. (Roscoe B. Jackson Memorial Lab., Bar Harbor, Me.). Sept. 7, 1962. Contract AT(30-1)-2313. 14p.

Progress is reported in studies on the effects of age and previous radiation exposure on the subsequent radiation sensitivity and recovery rate in mice. Preliminary results are presented from studies of sex and strain differences in radioinduced life shortening and physiological processes that correlate with longevity in 23 inbred strains of mice. (C.H.)

32733 (TID-16849) THE EFFECTS ON RAT BEHAVIOR OF DEVELOPMENTAL ABERRATIONS INDUCED BY IRRADIATION IN UTERO. Progress Report, November 15, 1956 to November 14, 1957. Sylvan J. Kaplan (Texas Technological Coll., Lubbock). Includes Appendices Contract AT(40-1)-1982. 99p.

Results are reported from a series of studies on the effects of irradiation on behavior and learning capacity of rats. One-hundred r of x radiation, when administered to rats on the first postnatal day, was found to be sufficient to cause impaired performance in their subsequent maze running. A differential effect was noticeable depending on age, sex, degree of difficulty of the task, genetic strain of the subject, and time of radiation. Data are tabulated. (C.H.)

32734 (TID-16977) AGING OF RAPIDLY AND SLOWLY RECOVERING COMPONENTS OF LETHAL RADIATION INJURY IN MICE. George A. Sacher and Douglas Grahn (Argonne National Lab., Ill.). June 1962. Contract [W-31-109-eng-38]. 16p. (UAC-6604)

The effects of age and sex on the radiosensitivity of mice were studied in animals exposed to daily radiation doses of 12 to 170 r/day at various ages ranging from 100 to 850 days. Data are presented graphically. Results indicate that increased disease morbidity in the aging populations is the predominant factor in decreased resistance at later ages. It is concluded that the later components of the lethal radiation injury process are like the early components in being relatively uninfluenced by age during the first half of adult life, and in showing a rapid decline toward the end of the life span, accompanied by greatly increased variability of response. (C.H.)

32735 (TID-16979) INVESTIGATIONS ON MUTABILITY OF POLYGENES AND ON UTILIZATION OF INDUCED GENETIC VARIABILITY. R. E. Scossiroli (Pavia, Italy. Universita. Istituto di Genetica). Aug. 1, 1962. Work Performed under Contract IAEA/US. 15p.

Data are tabulated on characteristics in R_2 and R_3 generations from radioinduced mutations of maize and wheat. The relation between dose of radiation and increase of genetic variance for quantitative traits is discussed. Observations on the R_2 and R_3 generations were used in a pilot selection experiment with Triticum durum, carried out under controlled selfing, on the relative amount of the additivity of the new genetic variation induced by the radiation treatment. (C.H.)

32736 (UR-615) MECHANISMS OF INJURY AND RECOVERY FROM WHOLE AND PARTIAL BODY EXPOSURE TO IONIZING RADIATION. S. M. Michaelson, L. T. Odland, and J. W. Howland (Rochester, N. Y. Univ. Atomic Energy Project). Aug. 10, 1962. Contract W-7401-eng-49. 42p.

The lethality of ionizing radiation is dependent on dose rate, as well as total dose. In the dog, the LD 50/60 dose is increased by 50% when the rate is dropped from 10 r/minute to 1 r/minute. The half recovery time for the dog is 8 to 9 days. Residual damage 3 to 9 months after an initial whole-body exposure amounts to 15 to 20% of the LD-50 as evidenced by a shift in the dosage mortality curve. Leukocyte changes reflect injury and recovery patterns, and leukocyte depression is related to radiation dosage. Fractionated exposures to four equal daily doses produces the same leukocyte depression as a single dose equal to the sum of the four. After serial whole-body exposure, leukocyte recovery is progressively depressed. Hematologic recovery occurs earliest among upper-body radiation survivors, more slowly after whole-body, and intermediate after lower-body radiation. Recovery appears to be related to the metabolic activity of the tissue. (auth)

32737 (USNRDL-TR-579) THE RADIOBIOLOGY OF TEETH. D. J. Kimeldorf, D. C. Jones, and T. J. Castanera (Naval Radiological Defense Lab., San Francisco). Aug. 31, 1962. 58p.

The literature regarding radiation effects upon teeth has

been summarized and reviewed. Radiation effects upon teeth have been observed in a variety of species including man. Where sufficient data are available to form a judgement it appears that the pattern of alteration is similar among species. The effects are dependent upon exposure factors and the stage of tooth development at the time of irradiation. If the dose is massive, the effects may also involve damage to the tooth supportive structures. Radiation alters or destroys those odontogenic cells which are actively proliferating and differentiating at the time of exposure. If irradiation occurs before the formation of hard tissues, it may destroy the tooth bud. Radiation at a later state in development may alter differentiation or arrest further growth. The severity of the effect is dependent upon the radiation dose. Mature tooth structures are affected primarily by relatively large doses although histologic evidence of damage in growing teeth of rodents may be detected with 25 r of x rays. The patterns of injury and regeneration for the various tissues of the tooth are presented. In terms of radiobiological mechanisms it appears that direct radiation injury to teeth consists primarily of an interference with mitosis of proliferative tissues and the impairment of metabolic processes in differentiating cells. (71 references.) (auth)

32738 (JPRS-14861(Excerpt)) EFFECT OF IONIZING RADIATION ON THE UPPER RESPIRATORY TRACT OF EXPERIMENTAL ANIMALS. R. I. Stepanova. Translated from Sovet. Zdravookhranenie Kirgiz., No. 2, 34-8(Mar.-Apr. 1962). 6p.

Histological examination of the tissues of the nasal septum, soft palate, tonsils, epiglottis, bone marrow, and internal organs from rabbits exposed to various doses of radiation showed definite morphological changes in the upper respiratory tract. The most severe changes were observed after exposure to whole-body, fractionated doses of 700 to 1250 r administered over a period of 15 to 50 days. Changes in the upper respiratory tract of animals exposed over the abdomen only, apparently originated as a reflex reaction to the effects of ionizing radiation. (C.H.)

32739 (JPRS-15018) ARCHIVES OF ANATOMY, HISTOLOGY, AND EMBRYOLOGY. Translation of Arkhiv Anatomii, Gistologii i Embriologii, 42: No. 4, 3-92(Apr. 1962). 161p.

Abstracts were prepared on 12 translated articles from the Russian language periodical Arkhiv anatomii, gistologii i embriologii (Archives of Anatomy, Histology, and Embryology), USSR Ministry of Health, Vol. 42, No. 4. (C.H.)

32740 (JPRS-15018(p.1-46)) SOME PROBLEMS IN RADIATION HISTOLOGY. V. P. Mikhaylov. Translated from Arkh. Anat., Gistol. i Embriol., 42: No. 4, 3-24(Apr. 1962).

Radiation histology is defined as the science of the development, structure, and activity of tissues in animal organisms that were exposed to ionizing radiation in doses exceeding the level of the natural background radioactivity. Radiation cytology is defined as the study of the general laws governing the reactions of the cell, as the basic form of life organization, to radiant energy. This forms a part of radiation histology, since all initial alterative processes originate in the ultramicroscopic structures common to all cells. It is postulated that radiation is an injurious factor and that in irradiated cells and tissues it causes various dystrophic changes and, in large doses, necrosis. During normal repair of radiation injury the normal structure of tissue is more or less restored, and it is impossible to distinguish between histological and histopathological manifestations. A number of concepts of radiation injury are reviewed. The morphological changes that develop in cells after irradiation, concepts of tissue radiosensitivity, and regeneration in tissues after radiation lesions are discussed in detail and illustrated by many examples. (83 references.) (C.H.)

32741 (JPRS-15018(p.47-63)) THE REPAIR OF RADIATION LESIONS IN THE DEVELOPING NERVOUS SYSTEM. A. A. Manina. Translated from Arkh. Anat., Gistol. i Embriol., 42: No. 4, 25-33(Apr. 1962).

Embryos and newborn rats were exposed to x radiation at doses ranging from 50 to 300 r. Changes in the central nervous system were traced dynamically at intervals of 6 to 24 hr beginning with 10-day-old embryos and extending to 30 days after birth. The findings are described in detail. Results showed that the central nervous system of the newborn rat has an exceptionally great capacity for repair of radiation injury. However, unlike other tissues, the ability of the various divisions of the nervous system to proliferate is preserved only in the period of tissue differentation of its cell elements, when fibroblasts are present. The regenerative process in the developing nervous system is characterized not only by the increase in level of mitosis common to all tissues, but also by the formation of numerous centers of cell division in the shape of rosettes. (C.H.)

32742 (JPRS-15018(p.64-72)) MORPHOLOGICAL IMPAIRMENT OF BONE MARROW INNERVATIONS IN THE EARLY STAGES OF ACUTE RADIATION SICKNESS. A. A. Otelin. Translated from Arkh. Anat., Gistol. i Embriol., 42: No. 4, 34-8(Apr. 1962).

Changes in the nerves supplying red bone marrow during the early stages of acute radiation sickness are described. A method is described that was developed for the extraction of marrow from the vertebrae and epiphyses of long bones without decalcifying it and the preparation of sections for microscopic examination. Results are reported from studies on 40 dogs sacrificed at various intervals up to 10 days after exposure to 640 r x radiation delivered over a period of 80 min. Twenty-four hours after irradiation initial changes were observed in the marrow nerves, and pronounced changes were observed 3 days after exposure. Hemograms at this time showed a marked decrease in the leukocyte count, erythrocyte count, and hemoglobin content. Histological specimens showed that structural changes were present in all nerve fibers. It is concluded that radiation injury to marrow nerves are correlated with changes in hematopoiesis. (C.H.)

32743 (JPRS-15018(p.73-82)) AN ELECTRON MICROSCOPIC STUDY OF NORMAL AND IRRADIATED STRIATED MUSCLE TISSUE DURING THE PROCESS OF REGENERATION. G. V. Yelyakova. Translated from Arkh. Anat., Gistol. i Embriol., 42: No. 4, 39-42(Apr. 1962).

Results are reported from an electron microscopic study of regenerating muscle tissues of rats after mechanical injury. One day prior to the injury some of the animals were exposed to 500 r of local x radiation. Regenerative changes were observed in all animals. Degenerative changes seen in the irradiated muscles became pronounced after 7 days and marked after 14 days. It is concluded that the changes in muscle fiber after irradiation have a latent period and are manifested during regeneration as suppression or depression of regenerative ability of the muscle tissue. In some cases irradiation also hinders the development of connective membranes and reduces phagocytic activity of macrophages, which affects the entire process of regeneration of the muscle tissue. (C.H.)

32744 (JPRS-15018(p.83-97)) POST-TRAUMATIC REGENERATION OF THE MUCOUS MEMBRANE OF THE SMALL INTESTINE DURING ACUTE RADIATION SICKNESS. E. (Ye.) V. Dmitriyeva. Translated from Arkh. Anat., Gistol. i Embriol., 42: No. 4, 43-52(Apr. 1962).

An investigation was made of the processes involved in post-traumatic regeneration of the mucous membrane of the small intestine of rats during the initial period and at the height of radiation sickness. Microscopic examination of histological sections showed that decomposition and inflammation developed within one day of the trauma, with extensive hemorrhages developing at the height of radiation sickness. The number of white blood cells migrating to the focus of injury was much less in irradiated than in control animals. Mitotic activity was also suppressed in the irradiated rats. The data indicate a great regenerative ability of intestinal epithelium even at the height of acute radiation sickness. This regenerative action is retarded in irradiated animals. (C.H.)

32745 (JPRS-15018(p.98-106)) HISTOLOGICAL CHANGES IN THE EPIDERMIS AFTER EXTENSIVE BURNS DURING ACUTE RADIATION SICKNESS. L. B. Berlin. Translated from Arkh. Anat., Gistol. i Embriol., 42: No. 4, 53-8(Apr. 1962).

A study of histological changes in the epidermis of young pigs showed a similarity in regeneration after 3rd degree burns in normal pigs and in those with radiation sickness. The regenerative processes were slowed down in the case of burns of irradiated animals. Changes were noted in the content and distribution of nucleoproteins and glycogen in regenerating epidermis during the second and third weeks after radiation exposure. These changes were attributed to tropic changes in the underlying tissues. (C.H.)

32746 (JPRS-15018(p.107-18)) THE PROBLEM OF MITOTIC REGIME OF THE CELLULAR TISSUES OF THE THYMUS GLAND DURING ACUTE RADIATION SICKNESS. Yu. P. Khussar. Translated from Arkh. Anat., Gistol. i Embriol., 42: No. 4, 59-66(Apr. 1962).

The dynamics of mitotic activity in cells of the thymus gland was studied in rats after exposure to whole-body irradiation at doses of 800 to 1,000 r. The number of mitoses per given area was counted in histological sections of thymus tissue from irradiated and control animals. Data are tabulated. Results indicate that regenerative processes in the irradiated thymus gland begin soon after exposure and reach a maximum at the height of radiation sickness. (C.H.)

32747 (JPRS-15018(p.119-27)) THE EFFECT OF A SINGLE IRRADIATION BY LARGE DOSES OF X-RAYS ON HUMAN AND MICE CELLS CULTIVATED FOR LONG PERIODS OF TIME IN VITRO. Yu. (U.) Min'. Translated from Arkh. Anat., Gistol. i Embriol., 42: No. 4, 67-72(Apr. 1962).

Observations are reported on 4 different strains of human and mice cells in tissue cultures subjected to single doses of x radiation of 2,000 to 4,000 r. Death of some cells resulted, while peculiar morphological modifications were induced in cells that survived. Healthy cellular colonies resulted from some cells exposed to doses of 2,000 r. Possible explanations are discussed. (C.H.)

32748 (JPRS-15018(p.128-34)) A COMPARATIVE STUDY OF RADIATION INJURY OF MALE AND FEMALE GAMETES IN THE PATHOGENESIS OF EMBRYO PATHOLOGIES OF RATS. E. (Ye.) A. Pozhidaev (Pozhildayev). Translated from Arkh. Anat., Gistol. i Embriol., 42: No. 4, 73-6(Apr. 1962).

Results are reported from a series of studies on the comparative radiosensitivity of male and female gametes in rats. Data are tabulated on the effects of x radiation on male and female gametes, based on the percent of implanted eggs and the number of embryos dying after implantation, and on injury to embryogenesis as a function of the interval between irradiation and impregnation. Data indicate that the effects of radiation on embryogenesis is conditioned by damage to the nuclear apparatus of the gamete. (C.H.)

32749 (JPRS-15018(p.135-43)) CHANGES IN THE LYMPHATIC BED OF THE MAMMARY GLAND OF WOMEN UNDER THE EFFECT OF RADIATION THERAPY. L. I. Gordeeva (Gordeyeva). Translated from Arkh. Anat., Gistol. i Embriol., 42: No. 4, 77-81(Apr. 1962).

The effects of radiation doses of 6,000 to 21,000 r on the lymphatic capillaries and ducts of the mammary gland were investigated in women of various ages subjected to surgery in connection with cancer of the breast after a course of pre-operative x ray therapy. Significant changes in the structure of the gland and lymphatic bed were observed in histological sections. These changes are described in detail. (C.H.)

32750 (JPRS-15018(p.144-50)) CHANGES IN THE INTRAORGANIC LYMPHATIC SYSTEM OF LYMPHOID FORMATIONS IN RABBITS DURING RADIATION SICKNESS. K. A. Malkhazova and V. N. Balashev. Translated from Arkh. Anat., Gistol. i Embriol., 42: No. 4, 83-7(Apr. 1962).

The radiosensitivity of the lymphatic system of the palatine tonsils and the appendix was studied in rabbits. Histological sections were prepared from animals killed at various times after exposure to doses of 900 to 1,200 r x radiation. Observations were compared with those on normal animals. Morphological and functional changes induced by irradiation resulted in increased permeability of the capillary walls. (C.H.)

32751 (JPRS-15018(p.151-9)) A STUDY OF REDUCED CIRCULATION OF THE PELVIC REGION OF RABBITS DUE TO THE USE OF RADIOACTIVE PHOSPHORUS. M. V. Les'kiv. Translated from Arkh. Anat., Gistol. i Embriol., 42: No. 4, 88-92(Apr. 1962).

Phosphorus^{32} was used as a tracer in studies of blood circulation in the pelvic region in rabbits. Ligatures were used on the external iliac artery in some animals and on both the artery and complimentary vein in other animals. Radioautograms were made of femurs with indirect and reduced blood circulation. Congestive symptoms developed in the legs within a few hours after ligatures were applied but the congestion disappeared on the third day. The results indicate that reduced circulation aggravates sciatic disturbances of the limb. Applications of radioisotopes as tracers in the study of disturbances of blood circulation in surgical practice are discussed. (C.H.)

32752 ENHANCED RADIATION REACTION IN THE VAGINAL SMEAR BY HUMORAL AGENTS AND SURGICAL SPAYING. Olle Kjellgren (Univ. of Göteborg). Acta Cytol., 6: 455-8(Sept.–Oct. 1962). (In English)

In 935 patients undergoing Ra therapy for cancer of the uterine cervix, attempts were made to improve the cytological response by various supplemental treatments. The cytological response was evaluated by following changes induced by radiation in exfoliated squamous cells present in vaginal smears. An improved response to radiation was based on an increase in cell size, the presence of binucleated cells and pyknotic nuclei, and cytoplasmic vacuolation. The maximal radiation reaction noted in vaginal smears occurred on the 11th or 12th day following Ra therapy by the intracavitary method. Patients with good

cytological responses had a singificantly higher ω-yr recovery rate than those who did not. This response was not significantly altered by concomitant treatment with testosterone propionate, α-tocopherol, α-tocopherol + testosterone, or oophorectomy. Thus, these results failed to confirm previous reports of the efficacy of supplemental therapy on the radiation response. (H.H.D.)

32753 ANIMAL EXPERIMENTS ON THE EARLY CHANGES IN MICROMOTILITY OF SMALL INTESTINE AFTER IN SITU DIRECT ROENTGEN IRRADIATION. A. Sántha (Health Service, Hungarian People's Army, Budapest). Acta Physiol. Acad. Sci. Hung., 20: Suppl., 20-1(1962). (In German)

By a direct contact apparatus, the small intestine of dogs was irradiated with 500 to 20,000 r and movements of the villous structures were observed. In contrast to the relative insensitivity of peristalsis to irradiation, villous motility showed changes in frequency and blood circulation with low doses after a brief latent period. The early stimulation of micromotility was followed by an immotile phase. The reaction was the same with single or fractionated radiation doses. The increased frequency during the 2nd half hr after irradiation was accompanied by increased tonus and dilatation of capillaries in villi, and then frequency fell to very low levels in the 2nd hr. The irradiated mucosa had an inflamed appearance, and antihistamine and phenothiazine drugs diminished the stimulation of micromotility. The threshold dose for this stimulation is ~1000 r, and the duration of the latent period is proportional to the dose. The possibility that the reaction may be mediated by histamine, necrosin, and other endogenous inflammatory agents is suggested. (H.H.D.)

32754 THE EFFECT OF DEUTERIUM OXIDE ON THE MECHANICAL PROPERTIES OF MUSCLE. Ole Svensmark (Universitet, Copenhagen). Acta Physiol. Scand., 53: 75-84(Sept. 1961).

The effect of D_2O on the isometric contraction of frog muscle was investigated. In 99.8% D_2O, the twitch force was reduced to 2 to 70% of the force in aqueous Ringer solution, the rate of force development to 12 to 30%, the tetanic force to 61 to 96%, while the latency of force development was approximately doubled. The total duration of the twitch was unchanged. The duration of the plateau of max. intensity of active state remained unaltered while its decline was enhanced. The conduction time of the action potential was not affected but the reduction in frequency at which a complete tetanus could be maintained indicated an effect on the excitatory processes. The increase in latency of the mechanical response in D_2O is explained by its effect on the latency of the action potential. The reduction of twitch force and rate of force development by D_2O may be caused via changes in the coupling between excitation and contraction and by a direct effect on the contractile substance. That reaction rates rather than final states are affected is consistent with the observation of an almost unchanged tetanic force even where the twitch force and the rate of force development were reduced to one-fifth or less by D_2O. (H.H.D.)

32755 CHANGES IN THE LUNG FOLLOWING IRRADIATION THERAPY FOR CARCINOMA OF THE BREAST. Kalevi Kettunen (Maria Hospital, Helsinki). Ann. Med. Internae Fenniae, 50: 50-5(1961).

Results based on the radiotherapy of 145 patients are described. Irradiation was directed toward lymph nodes of the internal mammary chain and supraclavicular and axillary areas, the total dose of 3500 r being administered over a 3-week period. Roentgenographic evidence of post-irradiation pulmonary changes was detected in 58 subjects. In most cases the changes were minimal and were seen as a diffuse pleuritis or pneumonitis several weeks after therapy. Less frequently, fibrosis was detected, with linear strand-like densities extending outward and upward from hilus to apex of the lung. Shrinkage of the upper lobe was often observed many months later. In 5 of the 58 affected cases, the fibrotic changes resolved completely after 0.5 to 1.5 yr. Subjective respiratory complaints (dry cough, dyspnea, chest pain) attributable to radiotherapy were noted in 6 patients, but these symptoms did not persist and responded to conservative symptomatic treatment. (H.H.D.)

32756 ELECTRON MICROSCOPIC OBSERVATIONS ON THE LUNG IN IRRADIATED ANIMALS. G. Dragoni, G. Poggi Longostrevi, and L. Lombardi (Università, Milan). Atti accad. med. lombarda, 16: 379-89(Aug.-Dec. 1961). (In Italian)

Rats were irradiated in the thoracic region by a daily dose of 200 r for 12 days, to a total dose of 2400 r. One, 7, and 25 days later the ultrastructure of lung tissue was examined. This dose (LD_{50} for 30-day mortality) damaged various cytoplasmic organelles in alveolar epithelial cells. The first day after irradiation, the lamellar myelin-like inclusion bodies lost their usual structure and appeared to be transformed into osmiophilic lipid globules. This process was more marked 7 and 25 days later. Mitochondria became enlarged and their cristae fragmented. Nuclei initially retained normal chromatin structure but by 25 days chromatin granules accumulated on the periphery of the nucleus. Ergastoplasmic sacs expanded into vacuoles, and the villous protrusions of the epithelial cells became shorter and less numerous. Capillary endothelial cells also showed vacuolation, representing changes in mitochondria and endoplasmic reticulum. The above-mentioned changes in myelin inclusion bodies from a lamellar to an amorphous state appears to be a particular characteristic alteration of irradiated alveolar cells. (H.H.D.)

32757 EFFECT OF ROENTGEN RADIATION ON THE ESTERASE ACTIVITY OF RAT TESTIS. E. Anselmi, L. Arata, M. A. Severi, and P. Pecora (Università, Rome). Boll. Soc. Ital. Biol. Sper., 38: 360-2(Apr. 1962).

Since nonspecific esterase or aliesterase provides an index of the state of interstitial tissue in testis, the functional state of Leydig cells after irradiation should be indicated by this enzyme activity. Rats were made temporarily sterile by local testicular irradiation of 600 r, and enzyme activities were followed in testis 10, 20, 30, 40, and 50 days later. Activities were estimated with p-nitrophenyl acetate and p-nitro valerate as substrates. The radiation-induced lesions included gradual and complete destruction of germinal epithelium, late hyperplasia of interstitial (Leydig) cells (at 30–40 days), and reduction in the number of seminiferous tubules. By the 10th post-irradiation day the esterase activity with the 1st substrate was increased 3-fold and that with the 2nd substrate was increased 2-fold; both total and specific activities were increased. The activities fell gradually but were still elevated to more than 50% above controls by the 50th day. The results indicate that, while radiation destroys germinal epithelial cells, it stimulates the proliferation of interstitial cells. (H.H.D.)

32758 EFFECT OF ROENTGEN RADIATION ON β-GLUCURONIDASE IN RAT TESTIS. L. Arata, R. Santoro, M. A. Severi, and P. Pecora (Università, Rome). Boll. Soc. Ital. Biol. Sper., 38: 362-5(Apr. 30, 1962).

The testes were irradiated with a single 600-r dose and enzyme activity was determined in homogenates of testis,

at 10-day intervals, up to the 50th postirradiation day. In comparison with the control value of 47.9 (units/mg fresh tissue), β-glucuronidase activity fell to 30.5 by the 10th day, then progressively rose to 78.4, 126.0, 242.0, and 275.0 in the subsequent 10-day periods. A parallel drop, followed by a rise, occurred in total activity of testis. Testicular weight fell, and seminal vesicular weight fell and then rose, during the 50-day period. Thus, the transient sterility and destruction of germinal epithelium induced by irradiation were reflected by a decrease in β-glucuronidase activity, whereas regeneration of this epithelium followed the rise in enzyme activity. Such parallel changes in epithelial function and enzyme activity were previously noted in vitamin E-deficient rats. (H.H.D.)

32759 HISTOPHOTOMETRIC STUDY OF THE EARLY POSTIRRADIATION CHANGES IN CYTOPLASMIC RIBONUCLEIC ACID OF GANGLIONIC CELLS OF GASSERIAN GANGLION OF RATS IRRADIATED WITH Co^{60}. M. L. Tognacca and R. Sorrentino (Università, Messina, Italy). Boll. Soc. Ital. Biol. Sper., 38: 428-30(May 15, 1962).

The head of rats was irradiated with a single dose of 1500 or 3000 rad, delivered at the level of gasserian ganglion, and changes in RNA were studied 10 min, 6 hr, 24 hr, and 7 days later. With both radiation doses, the RNA levels in ganglion cells showed a drop at 10 min and, after a slower decline, reached minimal levels by the 6th hr, then rose again to preirradiation values by the 7th day. The levels had practically returned to normal by the 24th hr. The drop in RNA was only slightly greater with the higher dose than with the lower dose. With both doses, only the 10-min and 6-hr decrements were statistically significant. (H.H.D.)

32760 HISTOPHOTOMETRIC STUDY OF THE EARLY POSTIRRADIATION CHANGES IN DEOXYRIBONUCLEIC ACID OF GANGLIONIC CELLS OF GASSERIAN GANGLION OF RATS IRRADIATED WITH Co^{60}. M. L. Tognacca and G. Savino (Università, Messina, Italy). Boll. Soc. Ital. Biol. Sper., 38: 430-3(May 15, 1962).

DNA was assayed spectrophotometrically in Feulgen-stained sections of gasserian ganglion of rats irradiated locally with 1500 or 3000 rad. DNA content of nuclei of ganglion cells showed a progressive drop when determined at 10 min, 6 hr, and 24 hr after irradiation at both dose levels. By the 7th postirradiation day, DNA content had returned nearly to normal. The fall in DNA was only slightly greater with the higher dose, and at the 24th hr was ~10%. Nuclear volume also declined slightly and reached a minimum by 24 hr. It rose only slightly thereafter, remaining below normal by the 7th day. (H.H.D.)

32761 A BIOMETRICAL-GENETIC STUDY OF IRRADIATED POPULATIONS IN RICE; GENETIC VARIANCES DUE TO DIFFERENT DOSES OF X-RAYS. Kuo-Nan Kao (Taiwan Provincial Coll. of Agriculture, Taichung, China), Chao-Hwa Hu, Wen-Tsai Chang, and Hiko-Ichi Oka. Botan. Bull. Acad. Sinica, 1: 101-8(June 1960). (In English)

Seeds of a representative Japonica rice variety of Taiwan, Taichung No. 65, were x rayed at different doses, and the resultant variations in several agronomic characters were surveyed in X_2 and X_3. For analyzing the data, formulas were constructed to obtain the expected radioinduced variances in the generations. The formulas proved that in X_2, the fixable part of the induced variance is distributed in the variances among and within lines in a 1:3 ratio, but in a 3:1 ratio in X_3. Analysis of the data by the formulas showed that in X_2, the induced variance increased in accordance with the dosage, but in X_3, the largest value appeared at 20 kr and decreased at higher doses. Heritability values also showed the same tendency. It was pointed out that selection of X_3 lines might be preferable for breeders, and the reduction of induced variances in plots irradiated at high doses, which might be due to elimination of unadaptable mutants, should be further investigated. (auth)

32762 THE UTILIZATION OF X-RAY RADIATION FOR RICE IMPROVEMENT. C. H. Hu, W. T. Chang, T. S. Weng, and H. W. Li (Taiwan Provincial Coll. of Agriculture, Taichung, China). Botan. Bull. Acad. Sinica, 1: 109-16(Dec. 1960). (In English)

X radiation was used to produce mutant lines in rice such as erectoides, early-maturing, rice-blast-resistant, and other types in 1957. Varying dosages of x-ray radiation were being used on 10 varieties of rice belonging to both Japonica and Indica types. Comparative tests were made with the original varieties in the X_4 generation. Fertilizer response tests were done in later generations. Erectoides were found, but they did not respond favorably to heavy fertility. Some early-maturing mutant lines yielded comparable to or better than their original varieties. Many high-yielding lines out-yielded their original varieties in either or both of the first and the second crops. It was interesting that three non-shattering mutant lines were found in one of the x-ray-treated Indica varieties. (auth)

32763 CYTOLOGICAL AND GENETIC CHANGES INDUCED BY X-RAYS AND THERMAL NEUTRONS IN RICE. Chuan-ying Chao and Shu-wen Chai (National Taiwan Univ., China). Botan. Bull. Acad. Sinica, 2: 15-25(June 1961). (In English)

Dry seeds of two rice varieties were treated with both x rays and thermal neutrons in two doses each. Comparisons of the effects were made between the two types of irradiations as well as between the two varieties as measured by seedling height, number of seedlings survived, chromosomal interchanges, pollen abortion, and seedling mutations. Seeds of both varieties treated with thermal neutrons were much more uniformly affected than x irradiated seeds as shown by the seedling height and number of seedlings survived. Intervarietal differences in response to both irradiations were observed. Seeds of the variety Taichung No. 65 after being irradiated with x rays and thermal neutrons produced more chromosomal interchanges than that of the variety Chianan No. 8. The reverse was the case for the seedling mutations. It was calculated from the data for chromosomal interchanges that 1 r of x rays was approximately equal to 1.4×10^9 nth/cm^2 of thermal neutrons. The relationship between the per cent of chromosomal interchanges and the per cent of pollen abortion was rather obscure. In testing the segregating ratio of the variegated type of chlorophyll deficient mutants, it was observed that temperature had an important effect on the expression of such mutants in the segregating populations. (auth)

32764 EFFECT OF X-RAYS AND THERMAL NEUTRONS ON CHROMOSOMES OF RICE. IV. MUTATIONS IN RICE INDUCED BY X-RAYS. Sung-ching Hsieh (Taiwan Agricultural Research Inst., Taichung, China). Botan. Bull. Acad. Sinica, 2: 43-50(June 1961). (In English)

Seeds of five Ponlai varieties (Japonica type) were irradiated with x rays and thermal neutrons. The relation of doses as well as kinds of radiation to the rate of chromosomal changes, and varietal differences in radiation sensitivity were studied cytologically with the first generation plants. Ring chromosomes and univalents were found at both diakinesis and first metaphase of pollen mother cells. The frequency of cells with ring chromosomes was proportional to the dosage of radiation. The effect of thermal neutrons appeared to be more serious than that of x rays.

Radiation doses producing 1% chromosomal interchanges were approximately 600r with x rays, and were 0.10×10^{13} nth/cm^2 with thermal neutrons. The biological equivalence value for chromosomal changes was then, calculated to be 1 r of x ray = 1.6×10^9 nth/cm^2 of thermal neutrons. Varietal differences in radiation response were proved with x-irradiated plants, but were not significant with thermal neutrons. (auth)

32765 ANALYSIS OF RECIPROCAL TRANSLOCATIONS IN RICE. V. MUTATIONS IN RICE INDUCED BY X-RAYS. Sung-ching Hsieh (Taiwan Agricultural Research Inst., Taichung, China). Botan. Bull. Acad. Sinica, 2: 111-17(Dec. 1961). (In English)

Fourteen reciprocal translocation homozygotes obtained through test cross of RT heterozygotes which were induced by x rays were intercrossed. The interrelation of interchanged chromosomes of the lines was studied cytologically by the aceto-carmine smear technic. RT analysis was made regarding the following respects: In F_1s between two RT lines; if all the chromosomes paired normally, the parental lines would have translocations in the same chromosomes; if a quadrivalent chromosome was formed, the chromosomes concerned in translocations in both lines would be the same though it is possible that their translocations are situated in different arms; if a ring of six chromosomes was formed, the parental lines would have one chromosome in common in their translocations; and if two rings of four were found, the parental lines would have quite different translocations. The result of RT analysis showed that at least three different RT lines out of 14 were identified, and five chromosomes out of 12 were involved in different reciprocal translocations within the materials. The percentage of good pollen in plant having 1(-)4, 2(-)4, and 1(-)6 were 50, 22.9, and 17.1%, respectively and showed good fits to the expectation. (auth)

32766 MUTAGENIC EFFECTS ON GAMMA RADIATION ON RICE. J. D. Soriano (Univ. of Philippines, Quezon City). Botan. Gaz., 123: 57-63(Sept. 1961).

Co^{60} irradiation of dry grains (Tjeremas variety of indica type of Oryza sativa) was carried out for the development of mutants of agronomic value for breeding with standard varieties. Progenies of selfed normal and aberrant plants were grown for several generations to detect variations. Doses of 20, 25, and 30 kr did not greatly reduce the percentage of germination while 40 and 50 kr killed most of the seeds. Seedling survival was markedly reduced following 30 and 40 kr, while no seedlings survived 50 kr. Seedling height was reduced following 30 and 40 kr, the plants having only 40% and 20%, respectively, the height of the controls, while following 20 and 25 kr, reduction in height was not great. Of 23 R_1 variations, 7 mutations were isolated and established in R_4 and R_5 generations, namely, albina, xantha, striped, bushy, spreading, slow-grower, and long awn. The chlorophyll-deficiency mutations and long awn have occurred spontaneously as gene mutations in other varieties but spreading and slow-grower have not been reported. The latter mutants and bushy are promising stocks for rice improvement. The only chromosomal aberration found in progenies of treated plants was heterozygous reciprocal translocation, recognizable by rings or chains of 4 chromosomes at metaphase I. A max. of 3 interchange configurations per cell was observed in highly sterile lines, indicating the possible breakage of up to 50.0% of the bivalents of the complement. (H.H.D.)

32767 DELAYED RADIONECROSIS OF THE BRAIN FOLLOWING THERAPEUTIC X-RADIATION OF THE PITUITARY. M. R. Crompton and D. D. Layton (National Hospital for Nervous Diseases, London). Brain, 84: 85-101(Mar. 1961).

Clinical and pathological findings are described in 2 cases of delayed radionecrosis of the brain following the irradiation of the contents of the pituitary fossa. They consisted of the recurrence of visual symptoms and the recurrence or onset of hypothalamic symptoms; of visual field defects unlike those usually seen in the recurrence of a pituitary adenoma; of necrosis of the hypothalamus, the inferomedial portions of the frontal lobes, the uncal gyri and the optic chiasm. The necrotic areas were characterized by the presence of a widespread, dense exudate of fibrin and degenerative and occlusive changes in the vessels. A region of degenerative change of grey and white matter containing narrowed and occluded vessels, lay adjacent to the central necrotic regions. The possible pathogenesis of delayed radiation necrosis on an allergic basis is suggested on the basis of these findings. Some or all of these appearances are seen in many conditions, throughout the body, in which the pathogenesis is thought to be allergic or due to hypersensitivity. The allergen may be the altered proteins of injured cells themselves. Thus there is evidence of alteration in the proteins of cells following irradiation and it is suggested that delayed radiation necrosis of the brain may be an allergic reaction to these altered proteins. The 2 cases showed the characteristic latent period between the cessation of x-ray therapy and the onset of terminal symptoms. The latent period was shorter in the case receiving the lower dosage of irradiation, which is unusual and for which no explanation can be given. Changes in the visual fields were unlike those usually seem in tumor recurrence and were similar to those sometimes seen in vascular disease of the optic nerves and chiasm. (H.H.D.)

32768 RADIATION MYELOPATHY. Christopher A. Pallis, Sydney Louis, and Rowland L. Morgan (Postgraduate Medical School, London). Brain, 84: 460-79(Sept. 1961).

A survey was made of 38 cases of radiation myelopathy with regard to early symptoms and signs, differential diagnosis, prognosis, nature of the primary lesion irradiated, and latency between irradiation and the development of neurological symptoms. Death occurred in 17 of these cases, 1 month to 4 yr after the first neurologic symptoms, as a result of the myelopathy. In most instances the blood vessels and stroma appear to have been predominantly involved. The latent period of several months between irradiation and onset of myelopathic symptoms suggests that the effect is primarily on blood vessels. The findings indicate that new limits should be advised for the permissible dose of radiation to the spinal cord. For treatment times of 42 days the limit for fields greater than 10 cm long should be 3,300 rads, and for fields less than 10 cm long, 4,300 rads. Idiosyncrasy is obviously a factor in the development of myelopathy, since the survey shows that many patients fail to develop the condition despite having received doses above 3,000 rads in 28 days (for large fields) or 4,300 rads in 42 days (for small fields). It is important to recognize the relative sensitivity of the spinal cord to irradiation, and to plan treatment accordingly. With conventional 240 kv machines (and with some Co^{60} units) the radiation beam has a wide penumba, which sometimes makes it difficult to avoid irradiating the cord (e.g., in post-cricoid cancer, where the irradiated volume must include the anterior surface of the cervical vertebrae). Supervoltage machines however, such as the linear accelerator, produce a very much better collimated beam with little penumbra, and with such machines it is usually much easier to avoid irradiating the cord. With

supervoltage radiation the energy absorbed in bone is very nearly equal to that absorbed in soft tissue, and the dose delivered to the spinal cord can therefore be estimated more accurately than with lower energy radiation. Thus, supervoltage radiation is probably the method of choice in the treatment of tumors adjacent to the spinal cord. (H.H.D.)

32769 EARLY CHANGES OF THE GROWTH ZONE IN THE RABBIT FOLLOWING ROENTGEN IRRADIATION: AUTO-RADIOGRAPHIC INVESTIGATION AFTER THE ADMINISTRATION OF RADIOSULPHATE. A. Hulth and O. Westerborn (Univ. of Uppsala). Brit. J. Exptl. Pathol., 43: 137-41(Apr. 1962).

Histologic changes and uptake of $S^{35}O_4$ by chondrocytes were studied in the epiphysial cartilage of young rabbits irradiated locally with 1000 r. Damage was perceptible in osteoblasts in metaphysis 6 hr after treatment. The osteoblasts were partially necrotic with pyknotic nuclei and were dislodged from the bone spicules. Blood-forming cells were reduced in number, and these changes persisted. No changes were seen in the epiphysial cartilage itself 6 or 48 hr after treatment, but 4 days after irradiation, abnormally large portions of the cartilage were seen to be devoid of cartilage cells. Pronounced changes in the epiphysial cartilage were present 10 days after irradiation. Proliferating cartilage cells were then concentrated in irregular aggregations separated by defibrillated matrix. The bone trabeculae on the irradiated side were shorter and fewer than normal. No definite changes in S^{35} uptake were perceptible 6 or 48 hr after irradiation, whether the S^{35} had been given 2 hr, 24 hr, or 5 days before death. Four days after irradiation, uptake of S^{35} 2 hr after the injection was less pronounced on the irradiated side, and some areas in the cartilage zone showed no activity. Ten days after irradiation the clumped cartilage cells were labeled, but their uptake differed from normal. Thus, 2 hr after S^{35} injection some cells in the proliferative zone were active in their entirety, while a number of large cells in the hypertrophic zone showed only slight activity. Thus, roentgen irradiation has a pronounced effect on growth, although this is not definitely demonstrable until 10 days later. (H.H.D.)

32770 IRRADIATION INJURIES OF THE PERINEUM. R. L. B. Beare (Queen Victoria Hospital, East Grinstead, Eng.). Brit. J. Plastic Surg., 15: 22-6(Jan. 1962).

Five cases are described in which multiple doses of radiation were applied to the perineal region for the treatment of pruritis ani or leukoplakia, resulting in chronic dermatitis or necrosis. It is suggested that these benign conditions should not receive radiation treatment. In 2 cases which were given many small doses of radiation over periods of 11 and 20 yr, respectively, squamous carcinomas were found in the irradiated skin. The recommended treatment in all cases was surgical excision of the burned area and repair by grafting. In 2 such operated cases, strictures developed which necessitated a second operation. (H.H.D.)

32771 X-RAY BURNS IN INDUSTRY. J. T. B. Bain and J. E. MacCabe. Brit. Med. J., 1: 1476-7(May 26, 1962).

Four cases of industrial x-ray burns, seen by industrial medical officers, which occurred in research and analytical workers using x-ray diffraction and x-ray spectrometer machines, are described. In 2 of the cases an x-ray fluorescent spectrometer was partly dismantled with the beam on, and fairly severe burns to the right hand resulted in each case. These healed uneventfully, if slowly. In the 3rd case a small burn occurred on the right hand after a few seconds' exposure while adjusting a beam aperture on an x-ray diffraction apparatus, the beam again being on. This also healed uneventfully. In the 4th case, however, the outcome was more serious; an analytical worker adjusted the beam of an x-ray diffraction apparatus, the machine being on. An unknown, but large, dose was received. Burns of the fingers appeared in a few weeks and failed to heal. Six months after exposure it was necessary to amputate the distal parts of the index and middle fingers. All the machines were standard pieces of apparatus and visible warning lights were on. Each incident was due to adjustment of the apparatus despite this warning. Although chemists and physicists may be theoretically conversant with the nature and properties of x-ray beams, they may lack a sufficient realization of the dangers of x-ray equipment. (H.H.D.)

32772 EFFECT OF GAMMA RADIATION ON THE FERTILITY OF AEDES EGYPTI. S. M. Ghosh, A. K. Hati, and S. P. Basu (Calcutta School of Tropical Medicine). Bull. Calcutta School Trop. Med., 9: 111(July 1961).

Studies were carried out on the effect of gamma radiation on A. egypti, the minimum dose required to produce non-reproductive males, and the minimum dose required to kill the eggs. The doses given were 500, 1000, 1500, 2000, and 6000 r for different batches of adults and 1000, 2000, 2500, and 3000 r for different batches of freshly laid eggs, each batch containing 100 eggs. Life span and feeding and mating habits of irradiated mosquitoes were similar to those of normal ones up to 2000 r although the number of eggs laid by a single female varied considerably. The size of the eggs and different stages of larvae compared favorably with the controls. After exposure of 6000 r, mating activities were less marked in males. Very few eggs were laid or none at all, and the eggs did not hatch. In females, however, normal activities were noted; the eggs hatched after a normal course and normal development of larvae and adults occurred. Eggs radiated with 1000 r hatched in a normal course of 1 to 3 days and the development of larvae was normal. With 2000 r only 50% of the eggs hatched and development of the larvae was delayed. Heavy mortality was marked. With 3000 r most of the eggs did not hatch, and the 1 or 2 larvae that hatched died immediately. It is concluded that the males of A. egypti required a much lower dose of gamma ray exposure for sterilization than females. The eggs can be killed by exposure to between 2000 and 3000 r. (H.H.D.)

32773 EFFECTS OF GAMMA RADIATION OF CULEX FATIGANS EGG RAFTS. S. M. Ghosh, A. K. Hati, and S. P. Basu (Calcutta School of Tropical Medicine). Bull. Calcutta School Trop. Med., 9: 156(Oct. 1961).

Egg rafts were exposed to 500, 1000, 1500, 2000, 2500, and 3000 r. With 500, 1000, and 1500 r, no variation in the time of hatching was noted as compared with controls. Most of the eggs hatched, metamorphosis from egg to adult was not delayed, and the adults that emerged from radiated eggs compared favorably with controls in size, vigor, and longevity. Progenies, followed up to the 5th generation, showed no abnormality. With 2000 r, however, most of the eggs did not hatch, and development of embryos was completely arrested. Only 25% of the eggs hatched in normal time and most larvae died during the 1st and 2nd stages, very few reaching the 3rd and 4th stage. A few pupated, many dying after pupation. The adults died soon after emergence and incomplete emergence from the pupal case was noted. With 2500 r, very few larvae hatched, and they died during the 1st and the 2nd stages of development. With 3000 r embryos were killed outright. Thus, the dose required for a lethal effect on egg rafts of C. fatigans is much lower than that required for Aedes aegypti eggs, which requires a minimum dose of 3000 r for a lethal action. (H.H.D.)

32774 INFLUENCE OF CASTRATION AND OF TESTOSTERONE ON THE RADIOSENSITIVITY OF THE MUCOSA OF THE RABBIT JAW. Michel Mairesse and Louis Darcis (Université, Liège). Compt. rend. soc. biol., 156: 407-9(June 12, 1962).

The influence of these treatments on the local irradiation of rabbit jaw with 1000, 1500, 2000, 2500, and 3000 r was investigated. Changes in the surface area of nucleated cells, scraped from the mucosal surface 3 to 10 days after irradiation, were followed. Irradiation with the highest dose increased the cell surface area 4-fold in intact untreated rabbits. The increase was proportional to the radiation dose. Continuous daily treatment with testosterone enhanced this effect of irradiation ~2-fold, whereas castration tended to inhibit the stimulatory effect of irradiation on cell surface area. These results confirm previous studies on rat vaginal mucosa and demonstrate that testosterone has a radiosensitizing action on mucosal cells. (H.H.D.)

32775 THE EFFECT OF FRACTIONATED DOSES OF X RAYS. I. EXPERIMENTS ON THE FLANK OF GUINEA PIGS. II. PRELIMINARY RESULTS IN A CASE OF BASAL CELL CARCINOMA AND IN A CASE OF ULCERATED CARCINOMA OF THE BREAST. A. Maggiora, R. Paillard, and W. Jadassohn (Clinique Universitaire de Dermatologie, Geneva). Dermatologica, 125: 174-83(1962). (In French)

Local irradiation of the skin of guinea pigs with 200 r/day 6 days/week caused epilation after 35 to 49 days, corresponding to cumulative doses of 6000 to 8400 r. The threshold single dose for epilation was ~800 r, which produced epilation after 11 to 15 days. With fractional doses of 100 r/day, epilation occurred after 100 to 160 days, or with cumulative doses of 8000 to 14,000 r. Ulcers appeared 63 to 145 days after 200-r daily doses, corresponding to cumulative doses of 11,000 to 25,000 r. No ulcers were noted after 100-r daily doses, up to total doses of 11,500 to 20,000 r, nor were any macroscopic changes in irradiated skin noted, other than epilation. On the basis of results obtained in these animal experiments, fractional therapeutic doses of x rays were applied to two inoperable patients with cancer, one with a basal cell carcinoma of the nose and another with metastatic breast cancer. Both cases were given daily doses of 25 to 50 r, up to total doses of 2800 r. The therapeutic results, which are illustrated, show regression of the superficial tumors and healing of previously ulcerated areas. (H.H.D.)

32776 EFFECTS OF IONIZING RADIATION ON THE CELL. E. Harbers (Universität, Gottingen, Ger.). Deut. Med. Wochschr., 87: 1395-9(July 6, 1962).

The effects of radiation on deoxyribonucleic acid and protein synthetic processes are reviewed. (H.H.D.)

32777 EFFECTS OF HEAT AND GAMMA RADIATION ON SELECTED SUBSTRAINS OF NEWCASTLE DISEASE VIRUS. Wayne Wolpert Kirkham (Iowa State Univ. of Science and Tech., Ames). Dissertation Abstr., 23: 400-1 (Aug. 1962).

Eight chicken embryo propagated laboratory strains of Newcastle disease virus, defined with respect to the thermostability of their hemagglutinating property were propagated in tissue culture monolayers to determine their cytopathogenic effect in chicken embryo fibroblasts. All strains with the exception of one produced a cytopathogenic effect evidenced by plaque formation. The strain multiplied in the system but did not form plaques. Small, medium, and large plaques were observed in the first passage for all of the substrains. The percentage of large plaques decreased with each subsequent passage of the medium and large plaque isolates. No large plaques resulted from the passage of small plaque isolates. After three passages through tissue culture cells, the tissue culture substrains were evaluated for the thermostability of their hemagglutinating, infective, and hemolytic properties. All of the substrains could be placed in either a heat sensitive or heat resistant group. The hemolysin, hemagglutinin, and infectivity were inactivated by heat in the order named. The most heat sensitive substrain and the most sensitive of the heat resistant group was derived from the same parent population. The substrains were subjected to gamma radiation (Co^{60}) and the decrease in titers of the infective property was determined. Exponential inactivation curves were similar for all substrains, indicating that the structure(s) associated with the infective property were similar in size. The fact that the infectivity of the various substrains tested was equally sensitive to gamma radiation but could be placed into two distinct groups with regard to heat sensitivity means that the component(s) of the virus which are affected by heat differ between the resistant and sensitive substrains.

32778 THE EFFECT OF HYPOTHERMIA ON THE SURVIVAL OF X-IRRADIATED RATS. H. Braun and K. Ammon (Universität Würzburg, Ger.). Fortschr. Gebiete Röentgenstrahlen U. Nuklearmed., 97: 217-21(Aug. 1962). (In German)

Experimental studies on animals were carried out to decide the question whether hypothermia applied before and after irradiation with x rays has any influence on survival and could perhaps be used for therapeutic purposes. It was possible to show that the resistance of rats against radiation increases with the decrease of body temperature. Prolonged refrigeration, however, exceeding the duration of a whole body irradiation leads to an increase in mortality rate and so does hypothermia applied after irradiation. This procedure has therefore no protective effects against radiation. A discussion follows of the radiation-biological effects which pertain to hypothermia. (auth)

32779 BIOCHEMICAL CHANGES IN BETA-IRRADIATED EPIDERMIS OF GUINEA PIGS. Joseph Tabachnick (Albert Einstein Medical Center, Philadelphia). J. Albert Einstein Med. Center, 10: 4(Jan. 1962).

A dose of about 3000 rep beta radiation was given by contact of Sr^{90} to the clipped skin surfaces of guinea pigs. At varying intervals, 1 to 60 days following exposure, epidermis was separated from underlying dermis and analyzed. In addition to dehydration, irradiated epidermis showed decreases in ribonucleic acid (RNA) and deoxyribonucleic acid (DNA) per mg dry weight. The RNA/DNA ratio increased progressively from 1.22 to 2.04 by the 3rd week and returned to normal by the 60th day following irradiation. There was no significant change in protein N. Increases in total free amino acid, ammonia, and urocanic acid were noted 3 days after exposure, well before any visible evidence of injury. These reached peaks about 15 to 30 days after irradiation when the increments averaged 45% above normal. This rapid, local increase in total free amino acid is noteworthy in view of early amino-aciduria reported in human beings within 12 hr after accidental exposure to 25 to 180 r whole-body irradiation. In contrast to reports of increased taurine and β-aminoisobutyric acid in the urine of these patients, no increase of these compounds in irradiated epidermis was found. Both β-aminoisobutyric acid and β-alanine (intermediates of thymine and uracil catabolism) were absent in normal and irradiated tissue. Ion-exchange chromatography was used to isolate 22 free amino acids from normal and irradiated epidermis. There was no significant change in the pattern. Each showed a quantitative

increase on a dry weight basis, 3, 6 and 15 days postirradiation. The recent finding of ornithine and urea in acid-soluble extracts of guinea pig epidermis indicates that the content of water-soluble N compounds in this rodent tissue is similar to that found in man. There is a decrease in urea content by the 3rd day postirradiation, accompanied by an increase in ammonia. (H.H.D.)

32780 BIOLOGICAL EFFECTS OF DEUTERIUM OXIDE. Edward L. Rothstein (Albert Einstein Medical Center, Philadelphia). J. Albert Einstein Med. Center, 10: 8(Jan. 1962).

D_2O was used to study the synthesis of viral nucleic acid and cellular lipids. Deuteration of bacterial and mammalian cells resulted in increased size and an altered lipid profile. Infection of Escherichia coli with phages T5 and T7 resulted in the production of increased amounts of T7. Such increases were apparently a function of deuteration in the life cycle of the virus. Similarly, the HeLa cell, maintained in tissue culture, produced increased amounts of polio virus when cells were deuterated. (H.H.D.)

32781 EFFECT OF RADIATION ON UREASE. E. Anne Dickens (Albert Einstein Medical Center, Philadelphia). J. Albert Einstein Med. Center, 10: 9(Jan. 1962).

Solutions containing urease, urease and $(GES)_2$, and urease-SEG in 0.047M sodium phosphate buffer at pH 7.5 were given doses up to 750,000 r with Co^{60} gamma rays. The specific viscosity of urease decreases and then levels off at about three-fourths the original value. The viscosity in the urease solutions containing $(GES)_2$ did not decrease as much as the urease-SEG solutions after irradiation. The enzymatic activity is partially restored by gamma irradiation. Irradiation of solutions of urease containing $(GES)_2$ results in complete destruction of enzymatic activity. The viscosity changes in irradiated urease solutions are interpreted as indicating intramolecular rearrangement. (H.H.D.)

32782 EXPLORATORY STUDIES ON GAMMA RADIATION FOR THE STERILIZATION OF THE BOLL WEEVIL. T. B. Davich and D. A. Lindquist (U. S. Dept. of Agriculture, College Station, Tex.). J. Econ. Entomol., 55: 164-7 (Apr. 1962).

The effect of 2,500- to 10,000-r Co^{60} radiation on Anthonomus grandis adults, pupae, and eggs was determined. Longevity and egg-laying capacity of reproducing weevils were drastically reduced at doses of 5,000 r or higher, whereas egg hatch was greatly reduced at doses as low as 2,500 r. Exposure of virgin males to 10,000 r resulted in transient sterility whereas 15,000 produced permanent sterility. However, these doses resulted in rapid mortality of both sexes. A ratio of 3.8 : 1 : 1 of sterilized males : normal males : normal females did not affect egg laying or hatch. There appeared to be little, if any, effect of adult boll weevil age on susceptibility to the lethal effects of gamma rays. Emergence of adults from prepupae, young, and old pupae exposed to 10,000 r was eliminated, greatly reduced, and unaffected, respectively. However, the lethal effects carried over because of the adults died within 2 weeks. Exposure of eggs to 600 r did not affect hatch or subsequent development whereas 2,400 r markedly reduced hatch and prevented subsequent development. (H.H.D.)

32783 EFFECT OF RADIATION ENVIRONMENT ON THE THERMAL RESISTANCE OF IRRADIATED SPORES OF CLOSTRIDIUM SPOROGENES P.A. 3679. J. J. Licciardello (Massachusetts Inst. of Tech., Cambridge) and J. T. R. Nickerson. J. Food Sci., 27: 211-18(May-June 1962).

The thermal resistance at 100°C of Clostridium sporogenes P.A. 3679 was determined after the spores were irradiated with gamma or cathode rays under various environmental conditions. The pre-irradiation treatment sensitized the spores to heat, and spores irradiated either in air or under vacuum were heat-sensitized to the same extent. The heat sensitization induced was slightly greater when the spores were irradiated at a pH near neutrality, than at an acid pH. Spores suspended in phosphate buffer (pH 7.0) were heat-sensitized to a greater degree than spores suspended in nutrient broth or pureed ham. The thermal resistance of the irradiated spores was not influenced by the concentration of viable spores in the suspension (phosphate buffer), but as the proportion of dead cells and dead spores increased with increasing doses of irradiation, the thermal resistance also increased. Spores irradiated with 660000 rep at 66–68°C were more heat-sensitive than spores irradiated at room temperature or in the frozen state. Below this irradiation level the effect was not evident. (Public Health Eng. Abstr. 42: No. 9, Sept. 1962)

32784 THE RADIOSENSITIVE NATURE OF HOMOGRAFT-REJECTING AND AGGLUTININ-FORMING CAPACITIES OF ISOLATED SPLEEN CELLS. Franco Celada and Rachel R. Carter (Oak Ridge National Lab., Tenn.). J. Immunol., 89: 161-9(Aug. 1962).

A new and major modification of the in vivo culture technique was used to study the agglutinin-forming and homograft-rejecting capacity of known numbers of cells in a quantitative way. Spleen cells of two parents (P_1 and P_2) are cultivated in vivo in irradiated, immunologically inert ($P_1 \times P_2$) F_1 hybrid mice, and the killing effect of P_1 and P_2 cells is assessed by measuring the suppression of agglutinin formation by P_2 cells. The data show that the homograft-rejecting capacity is more radioresistant than the agglutinin-forming capacity. This shows that a difference exists at the active cell level between the two capacities, and suggests that either two somatic cell lines or two maturation and/or differentiation stages are responsible. The higher radiosensitivity of C57BL than C3H agglutinin-forming cells indicates that the difference in LD_{50} dose among mouse strains (~ 520 r for C57BL and ~ 570 r for C3H) has its basis in a radiosensitivity which is a cellular characteristic of each strain. Primary homograft reactivity against strong antigen is relatively resistant to radiation. However, homograft reactions against weak tissue incompatibility factors appear to be efficient at relatively high radiation doses. (H.H.D.)

32785 CONCENTRATION OF Sr^{89} IN COMMON BONE TUMOR SITES. William A. Sybers and Joseph F. Kuzma (Marquette Univ., Milwaukee). J. Lab. Invest., 11: 686-7 (Aug. 1962).

Sr^{89}, a pure β emitter with rapid and selective accumulation in skeletal tissue, is known to produce malignant bone tumors in many species of animals. However, observed species and strain differences in the anatomical distribution of Sr^{89}-induced bone tumors have not been explained. E.g., the concentration of Sr^{89} in femurs as compared with tibiae is similar in mice and rats, but rats have mostly tibial tumors, while mice have femoral tumors. This would suggest that local high concentrations, local metabolic differences, or geometric patterns may be more significant in the production of bone tumors than average concentration of isotope in whole bones. The specific activity of Sr^{89} at selected bone sites was determined at intervals in mice and correlated with data on tumor distribution. This provided data on the redistribution of Sr^{89} over the course of 120 days after injection. The relative concentrations of Sr^{89} showed an in-

crease in the proximal femur and skull with time, no changes in lumbar and sacral vertebrae, and decreased concentrations in distal femur and proximal tibia. It would appear, therefore, that in mice given 2.5 μc Sr^{89} per g body weight intraperitoneally, the sites of high bone tumor incidence were those which had a high Sr^{89} concentration initially and which remained high during the course of 120 days. (H.H.D.)

32786 MULTIPLICITY REACTIVATION AND RADIATION STABILITY. N. Symonds (Hammersmith Hospital, London). J. Mol. Biol., 4: 391-21(Apr. 1962).

Evidence is presented that the resistance to inactivation by P^{32} decay of T4 bacteriophage-bacterium complexes, previously noted by Pratt, et al., ibid., 3: 409(1961), can be explained by the multiplicity reaction (MR) occurring between newly synthesized phage genomes. Intracellular synthesis of phage DNA commences about 5 min after injection in complexes of the phage T2 and T4; consequently a given dose of irradiation applied to the complexes at any time during this period will produce a constant amount of genetic damage (i.e., damage which prevents the phage DNA from acting as a pattern for the synthesis of new undamaged phage DNA). However, since certain biochemical steps leading toward phage synthesis will have been completed during this time, irradiation will cause a decreasing amount of functional damage. The complexes should therefore exhibit an increase in radiation resistance before the onset of DNA synthesis if some, at least, of the radiation-induced damage affected critical functions without of necessity causing irreparable genetic damage, in one of 2 ways: (a) the irradiation could produce some damage which was inherently only functional, or (b) a mechanism existed by which genetic damage was repaired or bypassed provided that the critical cistrons were intact. P^{32} decay causes no damage which is only functional in nature, so that the 1st possibility cannot explain the results of Pratt, et al. The phenomenon of MR, which is observed when multicomplexes rather than monocomplexes are irradiated, represents an example of the 2nd possibility. It is suggested that multicomplexes, but not monocomplexes, should show an increase in radiation resistance before the onset of DNA synthesis. This prediction was verified by comparing, during the early part of the latent period, the resistance to irradiation by ultraviolet light of monocomplexes and multicomplexes of phage T4. The multicomplexes began to show an increase in radiation resistance about 2 min earlier than the monocomplexes. The interpretation suggested for the experiments of Pratt, et al., presupposes that in multicomplexes efficient MR can occur between damaged parental genomes during the early part of the latent period. It must therefore be assumed that the physiological condition of the host bacteria must alter during the first minutes of the latent period in such a way that they can support the reactivation process. It may well be that this alteration is intimately related to the completion of the early essential biosynthetic steps in phage synthesis. (H.H.D.)

32787 X-RAY INDUCED INHIBITION OF GLUCONIC ACID AND PYRUVIC ACID OXIDATION IN BACTERIUM CADAVERIS. B. Rajewsky and H. Pauly (Max-Planck-Institut für Biophysik, Frankfurt am Main). Naturwissenschaften, 49: 326-7(1962). (In German)

The present study shows that the oxidation of gluconic and pyruvic acids is very resistant to x radiation in Bacterium cadaveris. In opposition to Escherichia coli and Staphlyococcus aureus, however, one finds an increased oxygen uptake at x-ray doses up to approximately 2 Mr, whereas at higher doses it is inhibited. The results do not agree with assumptions made for the derivation of the formula describing the dose-effect curve for a multi-stage process. (J.S.R.)

32788 EFFECT OF GAMMA IRRADIATION ON PIGS FED LOW VITAMIN A RATIONS. T. N. Meacham, T. J. Cunha, G. E. Combs, H. D. Wallace, A. C. Warnick, R. L. Shirley, and C. F. Simpson (Univ. of Florida Agricultural Experiment Station, Gainesville). Proc. Soc. Exptl. Biol. Med., 111: 30-4(Oct. 1962).

Pigs irradiated with 350 r bilaterally at the rate of 11 r per minute 9 feet from source survived an average of 254 hours. A moderate vitamin A deficiency had no effect on irradiation damage; in fact, the vitamin A low pigs lived an average of 2 days longer. Pigs fed low levels of vitamin A and with very low liver and blood vitamin A levels showed no gross manifestations of a deficiency of vitamin A. Feed intake and growth rate were fairly normal. Irradiation lowered the total white blood cell count rapidly. The major symptoms of irradiation damage were depression, skin hemorrhages, hemorrhaging from eyes and mouth, increased respiration, mild muscular spasms just prior to death, extensive hemorrhage of lymph nodes plus varying amounts of hemorrhage in the kidneys, heart, urinary bladder, intestine, and stomach. (auth)

32789 MAZE-LEARNING ABILITY IN RAT POPULATIONS AFTER A NUMBER OF GENERATIONS OF GONADAL IRRADIATION. J. F. McGregor and H. B. Newcombe (Atomic Energy of Canada Ltd., Chalk River, Ont.). Radiation Res., 17: 465-78(Oct. 1962).

Maze-learning ability has been studied since August, 1956, in offspring from irradiated and unirradiated rat populations. In three separate experiments, doses of 600 r, 800 r, and 1000 r of 2-Mev x rays were administered to the gonads of all males in each generation, immediately prior to mating, in populations consisting of 30, 30, and 60 mating couples, respectively. These and the corresponding control populations were studied over periods of 6, 4, and 2 generations, respectively. Maze-learning tests on unirradiated offspring from the irradiated and control populations in each generation, the tests extending over 6 weeks for any one animal, have been carried out on a total of 464 animals. No significant effect of irradiation on learning ability was observed in the 600-r experiment. However, in the two other experiments mistakes were made more often by offspring from irradiated populations, amounting to a 20% and a 36% increase in the actual numbers of errors in the 800-r and 1000-r experiments, the combined data for all generations being used in each case. The interpretation is complicated by a reduction in litter size in the irradiated, but not in the control, populations, and by the remote possibility of genetic drift in both the control and the irradiated groups. There is some evidence that the observed reductions in average learning ability are not due wholly to differences in the numbers of animals showing extremely poor maze performance. (auth)

32790 RADIOSENSITIZATION OF A MAMMALIAN CELL LINE WITH 5-BROMODEOXYURIDINE. N. Delihas, M. A. Rich, and M. L. Eidinoff (Sloan-Kettering Inst. for Cancer Research, Rye, N. Y. and Cornell Univ. Medical Coll., New York). Radiation Res., 17: 479-91(Oct. 1962).

Some radiobiological properties of a mammalian cell line after exposure to the halogenated nucleoside 5-bromodeoxyuridine (BUDR) are described. Incorporation of BUDR into the deoxyribonucleic acid of mammalian cells in culture to the extent of 1% was measured after 3 to 4 days of incubation with 6 μg of the analog per milliliter. An in-

creased x-ray sensitivity of about 2 and an increase in extrapolation number of survival curves were observed after exposure to the above-mentioned concentration of BUDR. In contrast to this, an enhanced sensitivity slightly greater than 1 and a decrease in extrapolation number were found after thermal neutron irradiation and identical treatment with BUDR. Theoretical calculations on x-ray energy absorbed by BUDR-exposed cells show that a negligible increase in energy is absorbed per cell with incorporation of 1% BUDR, as compared to unexposed cells. For analog-exposed cells, survival was found to increase when a single dose of x rays was administered 4 to 12 hours after cell plating. For unexposed cells, survival was found to be constant during that same period. (auth)

32791 STUDIES ON RADIATION-INDUCED MAMMARY GLAND NEOPLASIA IN THE RAT. VI. THE EFFECT OF CHANGES IN THYROID FUNCTION, OVARIAN FUNCTION, AND PREGNANCY. C. J. Shellabarger, G. E. Aponte, E. P. Cronkite, and V. P. Bond (Brookhaven National Lab., Upton, N. Y.). Radiation Res., 17: 492-507(Oct. 1962). (BNL-5825)

When 31 female Sprague-Dawley rats were exposed to a single total-body dose of 400 r of 250 kvp x rays on the fortieth day of age, 24 of the rats so exposed developed 43 mammary neoplasms within a 1-year period. Of 31 littermate control rats studied during the same period, only 3 rats exhibited single mammary neoplasms. When diethylstilbestrol was given to irradiated rats, both the incidence and the number of mammary neoplasms was depressed, indicating that for the maximum mammary neoplastic response to radiation the irradiation breast tissue must be subjected to the proper hormonal environment, and this appears to be provided by a normal estrus cycle. Diethylstilbestrol given to nonexposed rats did not induce any more mammary neoplasms than were found in nonexposed control rats. Hyperthyroidism, induced by exogenous triiodothyronine given after irradiation and maintained for 12 months, did not influence the incidence of rats with mammary neoplasia or the total number of mammary neoplasms. Hypothyroidism, induced by a continuous administration of propylthiouracil in the drinking water beginning after irradiations, reduced the incidence of rats with mammary neoplasia only slightly and further reduced the total number of mammary neoplasms, suggesting that hypothyroidism provides less than the optimum hormonal pattern for the maximum mammary neoplastic response to radiation exposure. When the ovarian area was shielded, including a portion of mammary tissue, the incidence and number of mammary neoplasms were reduced. This reduction of neoplastic response appears to be due to the fact that, as less breast tissue is exposed, the smaller the total neoplastic response becomes. When 30 rats were irradiated with the ovarian area shielded and then allowed to become pregnant (with and without lactation), 19 of these rats exhibited 29 mammary neoplasms. This slight increase in neoplastic response was not proved to be significant, although it is suggestive that the changes in hormonal patterns brought about by pregnancy may also influence the neoplastic potential of irradiated breast tissue. Immediately after parturition, with or without lactation permitted, the growth rate of the adenocarcinoma type of mammary neoplasm was diminished, suggesting that in this type of mammary neoplasm the growth rate may be hormone-dependent, a conclusion reached previously by others. Twenty-nine per cent of the mammary neoplasms found in the irradiated groups were of the adenocarcinoma type; no adenocarcinomas were found in non-irradiated rats. Neoplasms of the adenofibroma or fibroadenoma types were the most common types found in either exposed or nonexposed animals. The period between exposure and appearance of the first mammary neoplasm was 2 months in all irradiated groups. The comparable period for the nonirradiated was 12 months. Thus the irradiated female Sprague-Dawley rat develops a relatively high incidence of rapidly appearing mammary neoplasms as compared to nonirradiated rats, although the mammary neoplastic response to irradiation is subject to hormonal modification. This suggests that radiation-induced neoplasia, of this type in this strain of rat, is at least a two-stage process consisting of the induction phase, i.e., radiation injury, and the promoting phase, i.e., the hormonal influence to which the radiation injured tissue is subjected. The total incidence of neoplasia of the pituitary, thyroid, and adrenal glands and of the ovaries did not exceed 6% in the exposed animals, as compared to an absence of these neoplasms in the nonexposed animals. The numbers of these neoplasms were too small to permit meaningful conclusions to be drawn as to the effects of changes in thyroid function, ovarian function, or pregnancy and lactation superimposed on radiation exposure on neoplasia of the endocrine system. (auth)

32792 REPRODUCTIVE SURVIVAL OF CHICK EMBRYO CELLS IRRADIATED IN OVO AND IN VITRO. Gordon W. Philpott, Charlie W. Shaeffer, Jr., and L. J. Tolmach (Edward Mallinckrodt Inst. of Radiology, School of Medicine and Washington Univ., St. Louis). Radiation Res., 17: 508-13(Oct. 1962).

Reproductive survival of chick embryo wing bud cells has been measured in vitro, after irradiation with 220-kev x rays either in vitro or in ovo. The survival curves are of the multihit type, the exponential regions being characterized by mean lethal doses of 268 and 323 rads, and extrapolation numbers of 1.8 and 1 to 2, respectively. (auth)

32793 VARIATIONS IN RADIATION RECOGNITION BY THE MOUSE. Howard L. Andrews and Dorothy C. Peterson (National Inst. of Health, Bethesda, Md.). Radiation Res., 17: 514-20(Oct. 1962).

The avoidance pattern of mice free to choose either an exposed or a sheltered environment has been studied with an annular test space and with a variety of mouse strains. With penetrating radiation a simple avoidance pattern starts to develop at a dose rate of about 50 r/min. At higher rates a progressively increasing confusion pattern appears. This leads some animals to choose the radiation area rather than the shelter. At 200 r/min there are large differences in individual behavior, and avoidance as a group may be completely lost. There are some quantitative variations between mouse strains, but, in general, the behavior patterns are similar. With very soft x rays there was neither avoidance nor confusion at a surface dose of 1000 r/min, and only avoidance at 5000 r/min. This suggests that the lower centers of the central nervous system are primarily involved. (auth)

32794 ACUTE X-RAY LETHALITY IN THE CHINESE HAMSTER AFTER WHOLE-BODY AND PARTIAL-BODY IRRADIATION. Aldo N. Corbascio (Univ. of California School of Medicine, San Francisco), Henry I. Kohn, and George Yerganian. Radiation Res., 17: 521-30(Oct. 1962).

Acute radiation lethality was studied in the Chinese hamster, Cricetulus griseus, during the 100-day period after whole-body and partial-body exposure to 250-kvcp x rays. The results indicate this species to be one of the most resistant mammals thus far studied. After whole-body exposure, the dose-effect curve was best determined on day 40 in the male and on day 100 in the female. During 1959

to 1960, prior to the fifteenth inbred generation, the LD_{50} values were: male, 856 rads, and female, 784 rads. During 1961, additional determinations for the males of the fifteenth through the seventeenth inbred generations indicated the LD_{50} to be over 900 rads. Pentobarbital anesthesia (60 mg/kg, i.p.), may increase the LD_{50} by about 5%. During 1961, the pooled male and female data for posterior-body exposure under pentobarbital anesthesia showed the dose-effect curves on days 28 and 100 to be alike: LD_{50} = 1297 rads. The analogous data for anterior-body exposure indicated two modes of death, a rapidly acting one, estimated from the deaths occurring within a month of exposure, and a slowly acting one, which killed during the interval 40 to 100 days. (auth)

32795 COMPARISON OF MONTE CARLO CALCULATIONS AND EXPERIMENTAL MEASUREMENTS OF SCATTERED RADIATION PRODUCED IN A WATER PHANTOM BY PRIMARY RADIATIONS WITH HALF-VALUE LAYERS FROM 1.25 Mm Cu TO 11 Mm Pb. W. R. Bruce, M. L. Pearson, and H. E. Johns (Univ. of Toronto and Ontario Cancer Inst., Toronto). Radiation Res., 17: 543-54(Oct. 1962).

Calculated and measured spectra of scattered x rays were compared for primary energies corresponding to 1.25, 2.20, and 3.30 mm Cu HVL and for γ rays of Cs^{137} (661 kev, 6 mm Pb HVL) and Co^{60} (1.25 Mev, 11 mm Pb HVL) beams of area 25 to 400 cm^2. Agreement in the shape of the spectra is good. Exposure doses calculated on the basis of the theoretical spectra agree with ionization chamber measurements to better than ±10% at the highest and lowest energies and to within 3% at the intermediate energies. The differences are attributed to the inaccuracies inherent in the method used to modify the theoretical results for parallel beams to the experimental situation with finite source-to-skin distances, and to sampling errors in the Monte Carlo calculation of multiple scatter at the lowest energies. Within these limitations the results of the Monte Carlo method should be useful in calculating scatter x-ray spectra from parallel or diverging beams with energies between 50 kev and 1.25 Mev. (auth)

32796 SPECTRAL DISTRIBUTION OF SCATTERED RADIATION IN A WATER PHANTOM IRRADIATED WITH CESIUM-137 GAMMA RAYS. W. R. Bruce and M. L. Pearson (Univ. of Toronto and Ontario Cancer Inst., Toronto). Radiation Res., 17: 555-72(Oct. 1962).

The scattered spectral distributions for a Cs^{137} unit directed at a water phantom are presented for a range of depths and field sizes. The data may be used to determine the effect of these parameters on the LET of this radiation source. (auth)

32797 EFFECT OF X-IRRADIATION ON DISTRIBUTION AND PROPERTIES OF CYTOPLASMIC PARTICULATES OF RAT LIVER. J. F. Thomson and Y. E. Rahman (Argonne National Lab., Ill.). Radiation Res., 17: 573-8 (Oct. 1962). (TID-15322)

On the basis of distribution of enzyme activities, there was no effect of 1000 r of total-body x irradiation on the size distribution of mitochondria, lysosomes, or uricase particles of rat liver. There was also no effect of total body x irradiation on spontaneous swelling or phosphorylative capacity of rat liver mitochondria. Hence it is concluded that the effects of radiation on rat liver mitochondria in vivo must be very slight. (auth)

32798 QUANTITATIVE STUDIES ON THE RADIATION PATHOLOGY OF THE BONE MARROW OF SMALL LABORATORY MAMMALS. I. THE FILM-RATIO METHOD: ABSOLUTE COUNTS FROM FILMS PREPARED WITH SUSPENSIONS OF BONE MARROW CELLS. Frederic C. Ludwig and Henry I. Kohn (Univ. of California School of Medicine, San Francisco). Radiation Res., 17: 579-93(Oct. 1962).

A film-ratio method was devised in which absolute counts of suspended bone marrow cells were acheived by means of a lasting film on a microscopic slide, prepared with a medium containing standard particles (spores) in a known concentration. The ratio of cells to spores was determined by microscopic examination of the film. The marrow cell count = R (cell-to-particle ratio in film) times N (number of standard particles in marrow suspension). Such films have the advantage of not requiring immediate counting. Their examination is no more laborious than the conventional method (chamber count plus differential count). Uniformity trials were carried out, sources of variance were explored, and results were compared with those obtained with the hemacytometer and with the electronic counter. The method was shown to be practical in a trial experiment dealing with changes in the marrow of irradiated mice. (auth)

32799 STUDIES ON COLCHICINE, COLCHICINE DERIVATIVES, AND ENDOTOXIN IN IRRADIATED ANIMALS. Willie W. Smith and Ilo M. Alderman (National Inst. of Health, Bethesda, Md.). Radiation Res., 17: 594-607(Oct. 1962).

Colchicine when given 3, 2, or 1 day and trimethylcolchicinic acid methyl ether, colchiceinamide, colchiceine, and N-acetylcolchinol when given 1 day before irradiation caused an increase in survival of mice, provided they were more than 7 weeks old and the radiation dose one which causes death in approximately 1 to 4 weeks. Colchicine administration did not increase survival in irradiated rats, guinea pigs, and hamsters, although it caused mitotic arrest of marrow cells in each case. Mitotic inhibition was also evident in mice after a series of colchicine injections which abolished the effectiveness for survival of a single injection. Furthermore, in mice a much smaller dose of trimethylcolchicinic acid methyl ether inhibits mitosis than was required for increasing survival, although both effects were obtained with the same small dose of colchicine. These observations argue against the postulate that the effect on survival is mediated through mitotic arrest. A variety of biological effects of endotoxin and colchicine are compared, including their effect on survival of irradiated mice of different ages and animals of different species, and granulocyte mobilization in animals of different species. These studies do not contribute positive evidence for or against a common pathway for the hemopoietic recovery induced by the two compounds. (auth)

32800 EFFECTS OF IN VITRO X-IRRADIATION ON THE AMEBOID MIGRATION OF HUMAN LEUKOCYTES. Charles K. Levy and Melvin M. Ketchel (Worcester Foundation for Experimental Biology, Shrewsbury, Mass.). Radiation Res., 17: 608-13(Oct. 1962).

Human venous blood was x irradiated in vitro, and the ameboid migration of polymorphonuclear leukocytes was measured by the capillary tube technique. Capillary tubes filled with heparinized blood were centrifuged, resulting in a basal layer of red cells, an intermediate buffy coat of leukocytes, and an uppermost layer of plasma. After irradiation, the tubes were incubated vertically, and the distance the leukocytes migrated into the plasma was measured by means of an ocular micrometer. The migration of leukocytes in blood x irradiated with doses ranging from 25 to 150,000 rads was not significantly altered. Irradiation with

200 krad, however, caused a marked inhibition of leukocyte migration. When nonirradiated cells were combined with plasma irradiated without cells, the same degree of inhibition occurred as when cells and plasma were irradiated together. This latter finding indicates that the observed inhibition resulted not from an effect of irradiation on the leukocytes directly, but indirectly through a change in the plasma. (auth)

32801 LOW-LEVEL GAMMA IRRADIATION AND AUDIOGENIC SEIZURES. R. Stephen Tacker and Ernest Furchtgott (Univ. of Tennessee, Knoxville). Radiation Res., 17: 614-18(Oct. 1962).

Audiogenic seizures were tested in mice which had received 10 r of whole-body γ-irradiation on day 6, 11, or 16 after birth. The latency of first and of fatal seizures, the severity of seizures, and the incidence of fatalities were no different in the irradiated animals than in a comparable control group. The present study was similar to a previously reported one in which sensitivity of audiogenic seizures to low doses of radiation was reported. Although several possible bases for the discrepancy of the findings were discussed, none seemed very obvious. It was, therefore, concluded that the generality of the previously reported findings is probably limited. (auth)

32802 HISTOLOGICAL AND HISTOCHEMICAL ASPECTS OF THE THYROID OF ANIMALS IRRADIATED DURING HIBERNATION. C. Vassallo, A. Cavina Pratesi, and G. R. Bandirali (Università Delgi Studi di Pavia, Italy). Radiobiol. radioterap. e fis. med., 17: 71-86(Jan.-Feb. 1962). (In Italian)

After consideration of the histological and histochemical results on thyroids from animals irradiated while hibernating, it is shown that this endocrine gland shows a clear radioresistance in the hibernated animals. (auth)

32803 THE DISRUPTION OF EXCHANGE PROCESSES AS A FACTOR IN RADIATION-INDUCED INJURY TO THE CELL. A. M. Kuzin (Inst. of Biological Physics, Academy of Sciences, Moscow). Radiobiologiya, 2: 340-55(1962). (In Russian)

An attempt is made to show a direct relationship between metabolic changes, and mechanisms of radiation damage to the cell. An elementary calculation shows that with a dose of 1000 r, about 3×10^6 ionized and excited molecules are formed, and these excited centers react with various parts of the cell such as the nucleus, the mitochondria, etc. Changes in the electrical charge of the membrane structure (the zeta-potential) can be observed. There is a partial desorption of enzymes from the membrane surfaces. The most general changes in an irradiated cell are a suppression of oxidative phosphorylation, the loss of cytochrome C by the mitochondria, the suppression of DNA synthesis in the nucleus, a change in the properties of the synthesized DNA, fermentative depolymerization of DNA, the fermentative break-down of protein structures, and the fermentative break-down of mucopolysacharrides. The formation of anomalous metabolites such as peroxides and quinones with toxic properties are observed in the cell. The end biological effect of these processes may be a cessation of mitosis, a chromosomal abnormality, occurrence of a mutation, the formation of a giant cell, or death of the cell. With small irradiation doses, the content of thymidine in the synthesized DNA is changed due to suppression in the thymidinease system, and "errors" are likely to occur in the transmitted DNA structure that lead to mutation. If the "error" is great enough, the mutation is a lethal one. Thus, it can be seen that a series of complex processes take place in a cell damaged by radiation. Forty-four references are included. (TTT)

32804 THE EFFECT OF IONIZING RADIATION ON THE COMPLEX DNA-METHYLAMINE (THE PROBLEM OF RADIOSENSITIVE AND RADIORESISTANT FORMS OF DNA). P. I. Tseitlin and T. S. Usakovskaya (Inst. of Experimental Biology, Moscow). Radiobiologiya, 2: 356-61 (1962). (In Russian)

DNA combined with protein (DNP), high-molecular-weight DNA (deproteinized with chloroform and butyl alcohol), and DNA combined with methylamine (DNA-MA) were irradiated with x rays in a plexiglass cuvette. The initial viscosity of the DNA-MA complex was equal to the initial viscosity of the DNP protein complex, and was 40 to 50% less than the viscosity of the initial DNA preparation. The DNA-MA complex was similar configurationally to the protein complex (DNP). On irradiation with x rays, the DNA-MA complex was less radiosensitive than DNA, and behaved analogously to the DNP protein complex. No change in the ultraviolet absorption was observed at x-ray doses of 1000 to 10,000 r. No "aftereffect" (a continuous decrease in viscosity after irradiation) could be observed with DNA-MA or DNP, but an "aftereffect" was observed with the irradiated DNA preparation. DNA-MA complexes formed from irradiated DNA and unirradiated DNA were subjected to irradiation, and it was found that no additional decrease in viscosity was observed from the DNA-MA complex synthesized from irradiated DNA. Hence, it was concluded that on irradiation DNA undergoes a configurational change of a non-degradative type, as a result of which the DNA is converted to a radio-resistant form. (TTT)

32805 A NUMBER OF COMMON FEATURES IN THE MECHANISMS OF THE ACTION OF IONIZING RADIATION, AND OF HEAT OF DNA. G. P. Golubeva, D. M. Spitkovskii, and P. L. Tseitlin (Inst. of Experimental Biology, Moscow). Radiobiologiya, 2: 362-4(1962). (In Russian)

Two discreet states of DNA, an elongated state and a more compact form, were observed for the DNA molecule. The elongated form is more sensitive to the effects of radiation and of heat. A 40 to 50% drop in the characteristic viscosity of DNA is observed, when the elongated form is converted to the compact form of DNA. It is proposed that the effects of radiation and of heat should be additive in converting the elongated form of DNA to the compact form. DNA (0.003%) solutions with DNA molecular weights of 3.5×10^6 and 6.7×10^6 were subjected to heating at 84°C in 0.14 M NaCl, and to x-ray doses of 5000 to 10,000 r. It was found that the characteristic viscosity fell to a limiting value of 40 to 50% of the initial values. The ultraviolet absorption at 260 mμ was unchanged by the heating or irradiation, and this indicated no change in the hydrogen bonding of the macromolecules. Thus, the effects of irradiation and of heat are seen to be additive, and the structural parameters of the DNA solutions are modified by the effects of radiation and heat so as to correspond to the more compact form of DNA. (TTT)

32806 THE RELATION BETWEEN THE ELECTRICAL PROPERTIES OF IRRADIATED ERYTHROCYTES AND THEIR SUBMICROSCOPIC STRUCTURE. Yu. P. Vinetskii. Radiobiologiya, 2: 370-3(1962). (In Russian)

A 10% suspension of erythrocytes, isolated from human stored blood and from rat blood, was given a total dose of 60 kiloroentgens. The specific resistance, the capacity, and the tangent of the loss angle of the erythrocytes of man and of the rat were investigated over a wide region of frequency

from 5×10^2 to 5×10^6 cps. The measurements were carried out in 0.85% NaCl or in a 10.3% sucrose solution. The low-frequency resistance (at a frequency of 1 to 100 kilocycles per second) decreased by 82% two hours after irradiation. The high-frequency resistance (at 3 megacycles per second) fell by only 12%. The ratios of the low-frequency to high-frequency resistance were 27.3 (initial), 14.3, 9.5, 7.0, and 5.5 at 30 minute intervals after irradiation. The electron microscope investigation of the irradiated erythrocytes showed an increase in membrane thickness to 140 to 180 Å as compared to a normal membrane thickness of 60 to 70 Å. Micro ruptures and microaggregates were detected on the surface of the stroma. The change in the state of the membrane, which is visible under the electron microscope, can be correlated with the ability of the membrane to conduct an electric current at low frequencies. After incubation of the irradiated erythrocytes for 24 to 48 hours, a sharp drop in the electrical capacity was observed as well as a disintegration of the structural elements of the erythrocyte. (TTT)

32807 THE EFFECT OF VINYLPYRROLIDONE ON THE BIOLOGICAL ACTIVITY OF γ-IRRADIATED YEAST CELLS. Yu. P. Kozlov and A. I. Gorin (Moscow Univ.). Radiobiologiya, 2: 383-6(1962). (In Russian)

Diploid yeast cells of Saccharomyces vini of the strain Megri-139-B were irradiated in air with Co^{60} γ rays in an aqueous suspension of 7×10^5 cells/ml. The survival of the yeast cells was determined as a function of vinylpyrrolidone (VP), irradiation dose, and treatment time with VP before and after irradiation. At a dose of 37.5 kiloroentgens, a concentration of 2% VP was found to be optimum. Treatment of the yeast cells with 2% VP before irradiation was more effective in increasing the survival of yeast cells than treatment with 2% VP after irradiation. Yeast cells irradiated in water make a faster recovery from a 2% VP solution than from water alone. (TTT)

32808 VARIATIONS IN CARBOHYDRATE-PHOSPHORUS EXCHANGE IN MUSCLE TISSUE INDUCED BY γ-IRRADIATION. M. P. Silaev (Moscow Technical Inst. of the Meat and Milk Industry). Radiobiologiya, 2: 387-90 (1962). (In Russian)

Normal female rabbits, 2.5 to 3.0 kilograms in weight, were given a Co^{60} γ dose of 800 r. Tissue samples of the Musculus longissimus dorsi were analyzed for glycogen content by the anthranone method, for monosacharrides, inorganic phosphate, adenosine phosphate, and lactic acid. The maximum drop in glycogen content was found to occur 24 hours after the irradiation. A whole-body dose of 800 r resulted in a significant drop in total carbohydrate content (both monosacharride content and glycogen content). The content of adenosinephosphate remained essentially unchanged. Irradiated muscle tissue, stored at −5 to +3°C decomposed more rapidly than normal tissue. The content of glycogen was lower, and the free phosphate content was higher than in normal tissue. The adenosinephosphate decomposed more readily in the irradiated tissue. These differences in autolytic processes may be due to shifts in fermentative activity as a result of irradiation. (TTT).

32809 RADIATION DAMAGE OF YEAST AS A FUNCTION OF ITS PHYSIOLOGICAL STATE. E. M. Karabaev (Moscow Univ.). Radiobiologiya, 2: 414-17(1962). (In Russian)

The radiosensitivity, the oxygen effect, and the ability of yeast cells to recuperate after irradiation were investigated as a function of the process of germination and of the state of exhaustion of the yeast cells. A suspension of yeast cells of Saccharomyces vini of the Megri 139-B strain were prepared as an aqueous suspension, and irradiated with Co^{60} γ rays. Fresh and exhausted yeast cells showed the same percentage survival on irradiation in air. Germination of the yeast cells starts at 1.5 hours after incubation, and then increases sharply with time. With increasing germination, the percentage survivals of the yeast cells rises sharply. The recuperative ability of exhausted cells is less than that of fresh yeast cells (after a dose of 48 kr, the survival of fresh cells increased from 10 to 75% after 24 hours incubation, while the survival of exhausted yeast cells increased only from 10 to 17%). On removing oxygen during the irradiation, the percentage of survivals increases markedly for fresh yeast cells, but is much less noticeable for the irradiation of exhausted yeast cells. The oxygen effect is the same for germinated yeast cells as for fresh yeast cells. Yeast cells irradiated in a state of rest (no mitotic activity) show the greatest tendency to recuperate in the post-radiation period. (TTT)

32810 RESULTS OF A STUDY ON THE EFFECT OF IONIZING RADIATION ON THE RETINA OF THE EYE AND ON CERTAIN LIGHT-SENSITIVE SYSTEMS. G. G. Demirchoglyan, M. A. Allakhverdyan, A. B. Melik-Mus'yan, V. G. Ogandzhanyan, R. I. Pogosyan, A. A. Lalayan, and V. V. Vasilyan (I.A. Orbeli Physiological Inst., Armenian Academy of Sciences, Erevan). Radiobiologiya, 2: 442-9(1962). (In Russian)

The reactions of the nervous system which are very important for the understanding of the mechanism of radiation injury of the organism were studied by examining the effect of ionizing radiation on the retina, considered as a special, peripheral part of the central nervous system. The methods used included electroretinography or the recording of electrical potentials of the retina by means of contact-lens electrodes, microelectrode techniques, amperometric determination of the hydrosulfide groups in the retina, and the determination of the absorption spectrum of the visual purple rhodapsin together with histochemical analysis. Moths were used for the study, exposing the test insects to radiations of 1.5, 10, and 15 kr and using butterflies from unirradiated cocoons as controls. Results of this radiobiological study of the retina agree well with the previously established high radiation sensitivity of this organ, and indicate the importance of protecting it against exposure to ionizing radiation. (TTT)

32811 THE SOLUBLE PROTEIN CONTENT OF THE IRRADIATED NERVOUS TISSUE. P. F. Minaev and A. I. Chukhrova (Inst. of Biological Physics, Academy of Sciences, Moscow). Radiobiologiya, 2: 450-4(1962). (In Russian)

Studying the biochemical processes in irradiated nervous tissue, it was found that certain stages of the material metabolism, such as the oxidative phosphorylization and the oxidative assimilation of hydrocarbons, are radiation-sensitive while other processes are quite resistant. The problem was further investigated using a new method for studying the brain tissue; this method involved simultaneous chilling and bleeding of the brain, followed by washing with saccharose or physiological solution. The brains of cats and dogs were exposed to radiations between 15 and 20 kr. The results showed that exposure of the brain tissue to ionizing radiation does not affect the protein fraction or the electrophoretic mobility; on the second day after the irradiation a slight increase of the albumin fraction was noted without a change in the total amount of soluble proteins. (TTT)

32812 STUDY OF THE AFTEREFFECT OF RADIATION ON PLANT CELLS FROM THE VIEWPOINT OF RADIATION PROTECTION. N. I. Shapiro and E. M. Protopova (Bocharova) (Inst. of Biological Physics, Academy of Sciences, Moscow). Radiobiologiya, 2: 485-91(1962). (In Russian)

Dry barley seeds were tested for determining the aftereffect of radiation in view of developing protection against it. An attempt was made to differentiate between the effect of the primary neutrons on the irradiated cells and the delayed phenomena. No metabolic processes took place in the dry seeds at the time of the irradiation which was carried out by means of a Co^{60} γ source to an integral dose of 10 kr. The so-called "oxygen aftereffect" and the "temperature aftereffect" were determined by making use of a previously described method developed by the authors (Doklady Akad. Nauk SSSR, 126: 191(1959) and 133: 462 (1960)). The irradiated seeds were dipped in a 0.01 M solution of alanine. Results indicated that this amino acid exerts a postirradiation protective action as could be seen from the chromosome aberration. This property appears to be connected with the reduction of the oxygen-type aftereffect and probably involves a mechanism of nonspecific blocking of the access path of oxygen to the injured portion of the seed cells. (TTT)

32813 THE SIGNIFICANCE OF SCOLIOSIS IN POST-IRRADIATED WILMS'S TUMOR AND NEUROBLASTOMA. Philip Rubin, Robert B. Duthie, and Lionel W. Young (Strong Memorial Hospital, Rochester, N. Y.). Radiology, 79: 539-59(Oct. 1962).

Radiographic changes in the vertebrae are described that were observed following orthovoltage therapeutic irradiation in the treatment of Wilms's tumor, neuroblastoma, and medulloblastoma. Historical data and treatment factors are tabulated for 17 cases. Observations on the incidence and severity of scoliosis and accompanying bony changes in 13 cases are presented. A review of the findings showed that the degree of scoliosis that developed was not related to the the fields of irradiation, whether they were unilateral or bilateral, and that the osseous changes in the vertebrae, pelvis, or ribs. The use of irradiation with surgery in the treatment of Wilms's tumor is discussed. Radiological techniques are described to deliver maximum doses to the tumor and minimum doses to the surrounding normal structures in the treatment of these tumors. (C.H.)

32814 EFFECTS OF RADIATION THERAPY IN SURVIVORS OF WILMS'S TUMOR. Jerome M. Vaeth, Seymour H. Levitt, Malcolm D. Jones, and Charles Holtfreter (Univ. of California, San Francisco). Radiology, 79: 560-8(Oct. 1962).

This study is based on a group of 12 patients surviving five years or longer, of a series of 30 treated for Wilms's tumor at the University of California. In all the survivors, late tissue changes, skin pigmentation and atrophy, muscle atrophy, and deformities in the ribs, vertebrae, and pelvis were observed. The younger the patient at the time of irradiation and the higher the dose of radiation, the more severe were the skeletal changes. All of the postpuberty females had normal menstrual histories and had conceived. Three of these 4 women had a total of 11 normal children. (auth)

32815 CYSTEAMINE PROTECTION AGAINST IRRADIATION EFFECTS ON GROWING CARTILAGE. Lionel W. Young, Philip Rubin, and George Casarett (Univ. of Rochester, N. Y.). Radiology, 79: 569-75(Oct. 1962).

An experimental program evolved for study of protection of growing rat cartilage against the deleterious effects of irradiation. The chemical agent chosen for this purpose was cysteamine, since it represented the most successful agent to date. The degree of cartilage injury by graded doses of irradiation was determined as well as the degeee of injury by graded irradiation following intraperitoneal injection of cysteamine. Comparison of these degrees of injury reveals that approximately 50% protection occurs secondary to the use of cysteamine. The radiotherapeutic implications are discussed. (auth)

32816 RADIOTHERAPY IN CARCINOMA OF THE BLADDER: POSSIBLE COMPLICATIONS AND THEIR PREVENTION. Fernando G. Bloedorn, John D. Young, Carlo A. Cuccia, Raul Mercado, Jr., and Morris J. Wizenberg (Univ. of Maryland, Baltimore). Radiology, 79: 576-81(Oct. 1962).

The management of infiltrating carcinoma of the bladder is a difficult therapeutic problem and should be undertaken only in centers where a team of specialists with proper knowledge and training is available. The close co-operation between urologist, radiotherapist, and pathologist is indispensable. With the use of supervoltage, proper indications, adequate technic, and correct combination of irradiation and surgery, the treatment is generally well tolerated and the results are more encouraging than those reported a decade ago. Many reactions and complications can be avoided if certain important precautions are taken. The treatment should be conducted with patients in the best general condition, with good urological function, and freedom from obstruction and gross infection. The time and effort expended in correcting these factors are definitely repaid in the avoidance of reactions and improvement of results. Observations in a four-year experience at the University of Maryland Hospital are presented. (auth)

32817 LENTICULAR CHANGES ASSOCIATED WITH BETA RADIATION OF THE EYE AND THEIR SIGNIFICANCE. Charles I. Thomas, John P. Storaasli, and Hymer L. Friedell (Western Reserve Univ., Cleveland). Radiology, 79: 588-97(Oct. 1962).

A study was made of 186 patients receiving beta radiation to the eye from a Sr^{90} applicator for various ophthalmologic lesions. One hundred and fifteen patients had a detailed ophthalmologic examination at least eight years after treatment. In the vast majority of the remaining cases, corneal opacifications precluded this examination. Lenticular changes were found in 38 cases. The degree of lens opacification following irradiation is related to the surface dose but more specifically the dose received by the lens. Since these changes appear to be stationary and rarely interfere with visual acuity, the use of this type of therapy should not be considered precluded where other types of treatment are ineffective. One must weigh the possible production of lenticular opacifications with the therapeutic benefits of radiation. In the authors' experience, no complications have occurred which would contraindicate the proper use of this form of radiation therapy. (auth)

32818 RADIOPATHIES IN THE HAND OF THE SURGEON. Héctor Marino (Naval Hospital and Instituto Municipal de Radiologia y Fisioterapia, Buenos Aires). Rev. Latino-Am. Cir. Plastica, 6: 6-29(Mar. 1962).

Several cases are described in which severe radiation injuries occurred in the hands of surgeons during operative procedures requiring fluoroscopy. The radiation lesions appeared to be aggravated by the various mechanical traumas accompanying washing-up processes preceding surgery, including brushing the fingers, use of strong disinfectants and detergents, and sprinkling the hands with talcum before donning rubber gloves. These routine measures may cause acute eruptions of old radiation lesions.

Various phases in the development of radiation burns on the hands, from the initial dermatitis to the late necrotic changes, are discussed. Frequently, the early lesions are erroneously diagnosed as allergic eczema so that effective therapeutic measures may not be instituted soon enough. Plastic surgical repairs of finger lesions, in the cases described, are illustrated. (H.H.D.)

32819 EFFECT OF IONIZING RADIATION AND OF SOME RADIOMIMETIC COMPOUNDS ON THE CONSUMPTION OF OXYGEN BY NORMAL AND LEUKEMIC HUMAN LEUKOCYTES. G. Astaldi, G. Meardi, A. Pisani, and C. Poggi (Instituto Cita di Pavia, Italy). Rev. Med. Valparaiso, 14: 141-5(Sept. 1961).

Irradiation with 2,000 and 12,000 r decreased the O_2 uptake of normal and leukemic leukocytes. This effect was noted 20 min after irradiation and was greater with the higher dose. Leukemic cells, particularly those from myeloid leukemia, appeared to be less sensitive than normal cells to respiration inhibition by irradiation; before irradiation, leukemic cells utilized less O_2 than normal cells. Triethylenemelamine and methyl-bis(β-chloroethyl)amine were added to leukocyte suspension in concentrations of 1 to 0.001 mg/ml. Both compounds inhibited respiration of normal and leukemic cells within 20 min, to an extent proportional to the concentration. Leukemic cells showed less inhibition than normal cells. (H.H.D.)

32820 THE INFLUENCE OF TOTAL BODY IRRADIATION OF X-RAY ON THE SURVIVAL OF HOMOLOGOUS SKIN GRAFTS IN RATS. Chang-Hee Bak (Seoul National Univ., Korea). Seoul J. Med., 1: 291-6(Mar. 1961). (In Chinese)

The behavior of homologous skin grafts in rats irradiated with sublethal doses of x rays was studied. Wistar albino rats were used as recipients and donors were Long-Evans hooded rats. The sublethal doses of whole-body irradiation to normal Wistar rats were approximately 600–650 r and 500 r were estimated to be sublethal. The skin homografts of 2.0 cm × 2.0 cm from hooded donors to untreated Wistar recipients survived for 7 to 10 days, an average of 8.5 days, followed by the typical pattern of the skin homograft reaction; whereas of the 15 sublethally irradiated animals, 12 showed prolonged survival of the grafts from hooded donors, which were ultimately replaced by the host tissue with the chronic rejection pattern. None survived permanently. (auth)

32821 INVESTIGATION CONCERNING THE EFFECT OF WEAK RADIATION DOSES ON TISSUE CULTURES IN VITRO. Karl Peters (Universität, Tübingen, Ger.). Strahlentherapie, 118: 481-502(Aug. 1962). (In German)

The effect of weak radiation doses of Co^{60} was investigated using HeLa-cells (sub-strains "T" and "Gey"), human amnion cells, and mice fibroblasts (strain "L"). In preliminary experiments, problems concerning the sizes of the collectives, the statistical consideration of the criteria for damage, and the optimal cultivation medium were solved. The radiation doses were 20, 2, 0.2, and 0.02 r corresponding to the following dose rates: 10, 1, 0.1, and 0.01 r in 24 hours. Significant inhibitions of mitosis and cell damage in comparison to the control cultures could be observed for the HeLa-cell strain "T" after irradiation with 0.2 r. In case of the HeLa-cell strain "Gey" and the amnion cells the effective dose was 0.02 r. In the mice fibroblast strain "L" a significant inhibition of mitosis was found after irradiation with 0.2 r and a significant increase of the cellular damage could be found at 0.02 r. There was no difference in sensitivity between the malignant and benign cell strains. (auth)

32822 BIOLOGICAL EFFECTIVENESS OF 30-Mev ELECTRONS DEPENDING ON TISSUE DEPTH AND IN COMPARISON WITH 180-kev AND 31-Mev PHOTONS. Hedi Fritz-Niggli and Hans R. Schinz (Radiotherapeutische Klinik des Kantonsspitals, Zurich). Strahlentherapie, 118: 503-17(Aug. 1962). (In German)

It was found that 4 hour (±10 min) old embryos of wild strains of Drosophila which are identical in their phenotype have different radiation sensitivity. The 30-Mev-electrons were significantly less effective biologically than 180-kev-photons for 4 hour (±10 min) old embryos. The RBE was 0.7. The 31-Mev-photons were more effective than 30-Mev-electrons, but less effective than 180-kev-photons. The lesser effectiveness of the megavolt radiation is explained by its smaller ionization density in comparison with 180-kev-photons (100 ionizations/μ). The embryos register the difference between 6.3 ionizations/μ for 31-Mev-photons and 3 ionizations/μ for fast electrons. The dependence of the effect of ionization density on the stage of development of the object irradiated can be explained by the fact that the 1 hour old embryos (RBE-1) are damaged by direct effects and the 4 hour old embryos are damaged rather by indirect effects (irradiation products of water). The biological depth dose curve for 4 hour (±10 min) old embryos is in good agreement with the physical curve. (auth)

32823 THE EFFECTS OF INCORPORATED CERIUM-144 ON THE FERTILITY OF MICE AND THE DEVELOPMENT OF THEIR OFFSPRING. V. G. Kulikova. Trudy Inst. Biol., Akad. Nauk S.S.S.R., Ural' Filial, 12: 34-45 (1960).

The state of parent mice injected with radioactive cerium and the state of their offspring; reproducibility of control parent mice and their offspring; the amount of radioactivity transmitted to the offspring and the offspring's sensitivity to radiation were studied. White laboratory mice of both sexes aged 2-2.5 months were injected intraabdominally with 0.25 ml of a solution containing cerium-144 in doses of 0.5 or 1.25 μc/g of the animal's weight. ($LD_{50/180}$ and $LD_{50/86}$ respectively). The offspring's sensitivity to irradiation from a Co^{60} source was also studied when the offspring were aged 3 months (irradiated in a dose of 600 r) and 4 months (700 r). It was found that 0.02 – 0.03% of the cerium incorporated in the parent mice 2-3 weeks before the onset of pregnancy was transmitted to the offspring. The increase in weight of the parent mice in the series lagged behind that of the control animals, but the offspring from the test mice developed at the same rate as the control animals. The administration of cerium in a dose of 0.5 μc/g 2 weeks before the mice were paired had no effect on their fertility. With a greater period between incorporation of the cerium and pairing of the animals, the fertility of the females dropped, while the fertility of the males remained normal. Incorporation of the cerium in a dose of 1.25 μc/g 3 weeks before pairing reduced the fertility of both females and males, although the females proved more sensitive to radiation. The average number of mice per litter at various stages after introduction of the cerium in doses of 0.5 or 1.25 μc/g did not differ from the control animals. The fertility of the first generation of mice obtained from mice injected with 0.5 μc/g of cerium was the same as the fertility of the control animals. Offspring obtained from various combinations of crossing tests (0.5 μc/g) and control mice proved more resistant to irradiation with Co^{60}. Moreover, the females were more resistant to radiation than were the males. Resistance to radiation persisted for a long period of time. It was found that large amounts of radioactivity are trans-

mitted to the embryo via the placenta only in cases where the radioactive agent is administered to the body of the female during pregnancy. If the radioactive agent is incorporated a few days before the start of pregnancy, very little of it passes into the embryo. Cerium was incorporated in the females 2-3 weeks before the onset of pregnancy, due to which only an insignificant proportion of the cerium was transmitted from the mother to the offspring. Offspring from females injected with cerium had a higher resistance to radioactivity due to their previous irradiation in the embryonic stage. (OTS)

32824 CHANGES IN THE CENTRAL NERVOUS SYSTEM AFTER EXPOSURE TO IONIZING RADIATION. P. F. Minayev, A. M. Antonova, V. I. Kantorova, O. F. Logvinova, and A. P. Mironova (Inst. of Biological Physics, Academy of Sciences, USSR). Trudy Tashkent. Konf. po Mirnomu Ispol'zovan. At. Energ., Akad. Nauk Uzbek. S.S.R., 3: 53-8(1961).

Changes in the nucleic acid content and histological changes in the cerebellum of guinea pigs after localized exposure to x rays were studied. The DNA and RNA contents of the cerebellum (mean value in mg % for wet tissue) was estimated in 108 guinea pigs immediately after the exposure (before the appearance of cerebellar disorders); after 3-4 hours (initial phasis of changes); after 24 hrs. (peak of changes), as well as after 10, 15, 20, and 30 days; (period of gradual restoration). Immediately after the exposure the nucleic acid content appeared to be unchanged; after 3-4 hours a slight decrease was observed and after 24 hours the DNA content decreased by 27.9% and the RNA content by 26.4% compared to the control levels. Owing to the cerebellar edema prevailing at that stage however, the weight of the dried residue was 20% lower in the experimental animals than in the control animals. In the subsequent period (10-30 days) the nucleic acid level gradually returned to normal values. The cerebellum of 40 guinea pigs exposed to localized radiation in a dose of 9000 r and 65 guinea pigs exposed to 16000 r was investigated histologically. No gross changes were found immediately after exposure, but the microscope revealed some cell enlargement, beginning edema of the stroma, and tigrolysis in some Purkinje cells of the ganglion cell layer. Marked changes were found in all cortex layers, 3-6 hours after the exposure; only a few cells retained their normal appearance. 24 hours after the radiation, changes culminated in the destruction of numerous cells: in some parts all Purkinje cells were destroyed, in others their number was diminished. In parts of the cerebellum more remote from the exposed area the changes were correspondingly less intensive. During the period of restoration (10-22 days) the cerebellum was of smaller size and of gritty consistency; it was covered by superficial hemorrhages and contained necrotic areas, clearly demarcated against the healthy tissue. Slight changes or ectopic Purkinje cells still occurred. After exposure to 16000 r the changes were of similar character but more intensive. (OTS)

32825 A γ-RAY DEVICE WITH AN ACTIVITY OF 32,000 G-EQUIVALENT RADIUM (RESULTS OF SOME BIOLOGICAL INVESTIGATIONS). N. G. Darenskaya, M. P. Domshlak, L. B. Koznova, and V. G. Khrushchev (Ministry of Health, USSR). Trudy Tashkent. Konf. po Mirnomu Ispol'zovan. At. Energ., Akad. Nauk Uzbek. S.S.R., 3: 63-9(1961).

A new powerful γ-ray device, suitable for experimental irradiation of all types of laboratory animals is described in detail. The device was used to study the biological effects of very large doses of radiation to corroborate reports, according to which exposure to radiation at a higher rate produces less marked biological effects than the same dose administered over a longer period. In the experiments, 30 dogs, 20 rats, and 45 mice were exposed to 15000, 30000, and 50000 r, respectively. To compare the biological effect of rays emitted by the old and new device the 3 doses were administered at a rate of 387-500 and 2000 r/min, respectively. The biological effect was assessed by the survival time after the exposure and by the time of onset of convulsions. In dogs no significant difference in the survival time was observed, but rats exposed to the higher rate (2000 r/min) lived 27 hr 50 min compared to an average of 10 hours 27 min in rats exposed to the lower rate (387-500 r/min). In mice the difference were even more striking: 20 hours 28 min and 4 hours 26 min, respectively. Convulsions appeared very early in dogs exposed to the lower rate of radiation: after 10-20 min (total dose 15000 r) and 4 min (total dose 30000 r), respectively. Dogs exposed to 2000 r/min showed the first convulsions after 40-45 min (15000 r) and 20-40 min (30000 r), respectively. In rats and mice the interval between the exposure and the onset of convulsions was about twice as long as in animals exposed to the higher rate. The findings suggest that, in addition to specific features, an increase in the rate of administration may cause far reaching changes in the biological effect of high radiation doses. (OTS)

32826 THE RNS PROTEIN COMPLEX IN 0.14 M NaCl EXTRACT OF RADIATION DAMAGED CELL NUCLEI. Hanna Ernst (Heiligenberg Institut, Ger.). Z. Naturforsch., 17b: 487-9(July 1962). (In German)

In earlier studies a decrease of the total nitrogen in the albumin-globulin fraction extracted from isolated cell nuclei could be detected as a result of irradiation. In an attempt to characterize this nucleoprotein loss, the ribonucleic acid-protein complex (RNP) was precipitated and its composition was investigated in dependence on the time after irradiation. The results showed that in the nitrogen and RNS balance of NaCl extract of the liver cells, only a third of the RNS and 15% of the protein-nitrogen are bound in the form of the RNP complex. The RNS concentration is changed neither in the total fraction nor in the RNP complex when the rats are exposed to 1000 r although the nitrogen concentration of the nucleoglobulin fraction per irradiation is subjected to statistically sure variations. It is shown that the nucleoglobulin nitrogen decrease occurring after irradiation must result in the "free" globulins and that the extractable RNS is subject to neither quantitative nor qualitative alterations. (J.S.R.)

32827 LÉSIONS PROVOQUÉES PAR LES RADIATIONS IONISANTES. (Lesions Induced by Ionizing Radiations). J. Delarue and L. Fruehling. Paris, Masson et Cie, 1960. 208p.

A series of papers by different authors dealing with anatomical lesions, tumors, and genetic effects induced by radiation is presented. (H.H.D.)

32828 CHARACTERISTICS OF THE FUNCTIONING AND STRUCTURE OF THE CENTRAL NERVOUS SYSTEM IN ANIMALS SUBJECTED TO IONIZING RADIATION DURING THEIR EMBRYONIC DEVELOPMENT. I. A. Piontkovskii. p.6-24 of "Vliyaniye Ioniziruyushchego Izlucheniya na Funktsiyu Vysshikh Otdelov Tsentral'noy Nervnoy Sistemy Potomstva." Moscow, Medgiz, 1961.

A study was made of the structural changes and functioning of physiological systems in the adult animal, subjected to ionizing radiation during the antenatal period of development. The investigations involved the use of the conditional

reflexes and electro-encephalography methods. Animals were revealed born with a congenital functional weakness of the main nervous process as a result of ionizing radiation during antenatal development. Gamma and x-rays in doses of 200, 150, 50, and 20 r for rats and 300-400 r for rabbits served as activating agents. Irradiation during the embryonic development was conducted in 3 stages: preimplantation; the main organogenesis period; and fertile period. The spontaneous mobility was studied actographically by kimographic recording. The shaking-off reflex method was used to study the conditional reflex activity in the ontogenesis of rabbits. Special electroencephalographic studies were conducted on adult rabbits and observations of general biological development induces of the animals were recorded. Hematology checks of the mothers and offspring were made. Obtained experimental data were used to derive statistical information, the arithmetic mean, quadratic error-m, reliability index-P. Further morphology, histology, and histochemical studies of the animals brain subjected to ionizing radiation at various stages of the antenatal period were also undertaken. Results are given and discussed. It was concluded that one single action of x and gamma rays during the embryonic development results in after-effects lasting throughout the entire life of the animal, destruction of the chemistry-metabolism, and the functioning of the central nervous system. (OTS)

32829 CONDITIONAL REFLEX ACTIVITY OF WHITE RATS SUBJECTED TO X-RAYS AT THE PREIMPLANTATION STAGE OF EMBRYONIC DEVELOPMENT. Ye. V. Miklaskevskii and M. B. Gol'dberg. p.26-44 of "Vliyaniye Ioniziruyushchego Izlucheniya na Funktsiyu Vysshikh Otdelov Tsentral'noy Nervnoy Sistemy Potomstva." Moscow, Medgiz, 1961.

Biological features and the conditional-reflex activity of white rats, subjected to radiation at early stages of embryonic development, were studied. 155 three-to-four-month-old white female rats were used, resulting in 386 offspring of both sexes. The pregnant rat received a 200 r dose. Irradiation of the pregnant rat was noted to result in a delay in the term of birth and a drop in the number of offspring born. No deformities occurred in survived offspring born to rats irradiated on the 5th day of pregnancy. Their weight tallied with that of the normals. Data on conditional-reflex activity indicated that the experimental animals fell behind the normals in the absolute number of combinations needed to strengthen the reactions to presented sonar signal stimulants. A statistical analysis showed, however, that the differences are not significant and that the former can take priority over the normals in the absolute value of the reflex magnitude to a positive tone. The ratios of the conditional reactions to a strong and weak positive stimulant were found to be equal in both groups. The differential index was lower in irradiated animals. Functional testing revealed that the difference between the normals and experimental groups lay in absolute values of various indexes. Evaluation of the consecutive inhibition in the antenatal irradiated group revealed a lengthening of the latent period and a drop in the value of the postdifferential response reaction to a positive signal. A second series of experiments was conducted to determine the effect of radiation in later stages of life on the antenatal-radiated rats, starting at the 45th day of life. No significant difference was noted between irradiated and non-irradiated rats, in the number of combinations needed to strengthen the reaction to a presented positive sonar stimulant. An analysis of the magnitude of the conditional reaction to a positive sonar stimulant showed it to be less in irradiated animals. Strengthening of the differentiation is more easily accomplished in the experimental group. Data on strengthening, latent period, and percentage of conditional reactions present pointed to the fact that the irradiated animals differed very slightly from the normals, having only a lower reflex value to a positive sonar stimulant. (OTS)

32830 CHARACTERISTICS OF THE CONDITIONAL-REFLEX ACTIVITY IN WHITE RATS, SUBJECTED TO GAMMA IRRADIATION (Co^{60}) AT THE MIDDLE OF THE EMBRYONIC DEVELOPMENT PERIOD. H. G. Mikhaylova and Ye. V. Miklashevskii. p.46-? of "Vliyaniye Ioniziruyushchego Izlucheniya na Funktsiyu Vysshikh Otdelov Tsentral'noy Nervnoy Sistemy Potomstva." Moscow, Medgiz, 1961.

A study was made of the conditional-reflex activity in white rats, irradiated on the 12th day of antenatal development, using different radiation dosages. 22 female rats (16 experimental and 6 control) were used resulting in 188 offspring, (140 experimental, 44 control). Dosages of 50-150-200 r, at a dosage power of 6, 4-8, and 3 r/min were applied. Positive and negative conditional reflexes to a sonar stimulant, positive reaction to light or weak tone, and dynamic stereotype to the indicated signal stimulants were produced and functional tests characterizing the properties of the main nerve processes were performed in the final stage. Data were processed statistically. All the white female rats irradiated with gamma rays, at dosages of 150-200 r, acquired radiation sickness resulting in a leucocyte drop to 40-60% of the initial level and a drop in erthrocyte count by 1-2 million 1 mm^3 of blood. The birth data were delayed to the 24th-25th day. Those irradiated at the middle of the pregnancy period produced malformed offspring, with a low vitality (anomaly of the skeleton and eyes). Those irradiated on the 12th day showed a more sluggish conditional-reflex activity in postnatal ontogenesis, as compared to the control batch. Certain features in the degree of absolute and relative impairment of the main nerve processes were detected, depending on the acting dosage of radiation. Animals in all three experimental series did not differ noticeably from the normals in the rate of positive conditional-reflex occurrence. Those irradiated in the antenatal stage fell behind in the absolute quantity of combinations needed for strengthening the reactions to signal exciters. In addition to destruction of the central nervous system, animals subjected to antenatal irradiation showed signs of morphology impairment of the brain. (OTS)

32831 CERTAIN FEATURES OF THE HIGHER NERVOUS ACTIVITY IN RATS, SUBJECTED TO X-RADIATION AT THE END OF THE SECOND HALF OF THE ANTENATAL DEVELOPMENT. I. A. Kolomeytseva. p.62-8 of "Vliyaniye Ioniziruyushchego Izlucheniya na Funktsiyu Vysshikh Otdelov Tsentral'noy Nervnoy Sistemy Potomstva." Moscow, Medgiz, 1961.

A study was made on the higher nerve activity in rats, born to mothers irradiated with 50 and 200 r dose x rays, on the 18th day of pregnancy. Experiments were conducted on 183 offspring of 20 female rats. The birth period, number of baby rats in a litter, death in the first 30 days of life, birth weight, presence of malformation, maturity period, fur coverage, and appearance of teeth were also recorded. An actogram was made on the 30-40th day of life. Rats irradiated inter-uterinely, on the 18th day of embryonic development with 200 and 50 r dose x-rays had a much lower vitality, exhibit leukopenia, reduced weight, and delayed maturity. Irradiation on the 18th day of antenatal development resulted in 22% of the rats born with growth impairment (midgets) who, in turn, perished on the third week of

postnatal life. A study of the higher nervous activity of the experimental animals showed an earlier occurrence and a later strengthening of the positive conditional reflex to sound. Strengthening of the negative conditional reflex was delayed as compared to the normals, and in 54% of the animals, the differentiation did not strengthen at all. The animals were characterized by the presence of a lengthy retention of the orientation reflex, a large number of intersignal reactions, and a high motor stimulation. The higher nerve activity of the rats irradiated on the 18th day of antenatal development was characterized by an elevated exhaustion, a lower vitality limit, a drop in the strength of the main nerve process, and destruction of their mobility and equilibrium. (OTS)

32832 THE HIGHER NERVE ACTIVITY OF ADULT RATS, IRRADIATED DAILY WITH X-RAYS DURING THE EMBRYONIC PERIOD. V. N. Semagin. p.79-101 of "Vliyaniye Ioniziruyushchego Izlucheniya na Funktsiyu Vysshikh Otdelov Tsentral'noy Nervnoy Sistemy Potomstva." Moscow, Medgiz, 1961.

A study was made on the effects of small, fractionated daily doses of ionizing radiation, on the embryo to determine whether 10 or 1 r doses cause changes of the higher nerve activity in the adult state and whether the effect depends on the dose. Testing of the higher nerve activity was started on the 42nd day of postnatal development, in three stages: formation of conditional reflexes; work in the stereotype; and functional testing. 65 female rats were irradiated, subdivided into 3 groups: 23 offspring irradiated with 10 r each, 22—with 1 r each, and 20 control rats. Daily irradiation of pregnant rats with x rays in doses of 10 and 1 r (total of 200 r and 20 r) caused malformations in the offspring, in about 4-8% of the cases, an increased mortality in the early postnatal period, and subsequent increased illness. According to actographs on the 3rd week of postnatal development, the irradiated rats, as compared to the normals, showed an increased mobility and subsequent drop. A particularly sharp drop in the mobility was noted at the 4th week of the life. The development of mobility in irradiated rats was delayed. The 10 r dose had a greater effect than the 1 r dose. The conditional reflex method points out a weakening in the force of stimulation and inhibition in adult animals, irradiated daily during the antenatal period with doses of 10 and 1 r. The equilibrium and mobility were impaired when irradiation with both 10 and 1 r doses was performed, although apparently to a lesser extent than the force of stimulation and inhibition. Destruction of the connecting function was noted in all the irradiated rats: the connecting function was severely impaired in two out of 45 irradiated rats. A lesser number of animals with a strong higher nerve activity and a greater number of weak animals, with impaired equilibrium and inertia, were noted in the irradiated groups. A lower absolute and relative brain weight, and also a thinning of the brain cortex was noted in rats, chronically irradiated antenatally. The destructive action depended on the dose. The 10 r dose had a greater effect than the 1 r dose, both on the higher nerve activity as well as on the brain weight. (OTS)

32833 CERTAIN CHARACTERISTICS OF THE NON-CONDITIONAL AND CONDITIONAL-REFLEX ACTIVITY IN THE ONTOGENESIS OF RABBITS, IRRADIATED IN THE EMBRYONIC PERIOD. R. I. Kruglikov. p.102-13 of "Vliyaniye Ioniziruyushchego Izlucheniya na Funktsiyu Vysshikh Otdelov Tsentral'noy Nervnoy Sistemy Potomstva." Moscow, Medgiz, 1961.

The non-conditional and conditional-reflex activity in ontogenesis was investigated in rabbits, subjected to antenatal irradiation of 400 r on the 23rd day of embryonic development. Observations on weight, maturity, and the orientation reflex to sound and mobility were made on 3 or 6-day-old baby rabbits. The mobility was tested on the 20th day of life by counting the number of movements in 10 minutes. A total of 20 experimental and 14 control animals were investigated. Irradiation on the 23rd day of embryonic development with a dose of 400 r caused destruction of general development, becoming evident in the postnatal period (weight drop, earlier maturity, destruction of fur cover growth). The experimental animals, in addition to a general retarded development, showed severe impairment of the functioning of higher divisions of central nervous system: weakening of the processes of stimulation and inhibition and a tendency of the nerve processes to extensive irradiation; and a drop in mobility of the nerve processes whereby the inhibition process is more inert than that of stimulation; a delay in the cortex development of the large cerebral hemispheres and the subsequent relationship between the cortex and sub-cortex formations was thought to be the results of the functional impairment of the higher divisions of the central nervous system, observed in the experimental animals. (OTS)

32834 CERTAIN CHARACTERISTICS OF THE FUNCTIONS OF THE HIGHER DIVISIONS OF THE CENTRAL NERVOUS SYSTEM IN ADULT RABBITS, IRRADIATED DURING THE EMBRYONIC PERIOD. R. I. Kruglikov. p.114-27 of "Vliyaniye Ioniziruyushchego Izlucheniya na Funktsiyu Vysshikh Otdelov Tsentral'noy Nervnoy Sistemy Potomstva." Moscow, Medgiz, 1961.

Results of an investigation performed on adult rabbits irradiated on the 23rd day of embryonic development, regarding the functioning of the higher divisions in the central nervous system are given. The method of food procuring conditional reflexes was used, starting at the age of 4 months. The experiments were performed in 2 stages. Simultaneous complex stimulants were used during the first stage as the positive and inhibiting signals. During the second stage, simple light stimulants were introduced which had formerly been used as light components of the subcortex reactions, such as licking and washing. A morphology check was made at the 15-month period on some of the normal and experimental rabbits. A sharp difference was noted in their respective brains through macroscopic analysis. Adult rabbits, irradiated on the 23rd day of embryonic development with a 400 r x-ray dose, also displayed severe destruction of the higher central nervous system: A large number of omissions of the conditional specialized mobility reflexes was noted, whereby, in the first stages of investigation, a large number of omissions was primarily connected with the fact that the experimental rabbits displayed an inhibited specialized reaction in response to the conditional signal, whereas the general mobility reaction remained intact. Instability of certain conditional reflexes indicated severe disruption of the analyticosynthetic mechanisms of the cortex resulting in a predominance of parallel communications over successive ones. Instability of the specialized conditional reflexes, the presence of a large number of intersignal reactions, and data on the delayed occurrence of the first zero in response to the differentiated stimulant all indicated that the experimental animals had an extended stage of conditional reflex generalization. A strengthening of the conditional reflexes connected with their specialization was reached relatively late or not at all in the experimental rabbits. The process of internal inhibition was severely damaged in the latter. (OTS)

32835 A STUDY OF ELECTROENCEPHALOGRAMS MADE ON RABBITS, SUBJECTED TO IRRADIATION IN LATE EMBRYOGENESIS. A. M. Ovanitskii. p.128-140 of

"Vliyaniye Ioniziruyushchego Izlucheniya na Funktsiyu Vysshikh Otdelov Tsentral'noy Nervnoy Sistemy Potomstva." Moscow, Medgiz, 1961.

Results of an investigation into the functioning of the higher divisions of the brain in animals irradiated during embryogenesis is presented. Electrophysiological tests were made on seven rabbit litters, four of which were experimental, and three control. A 300 r dose of x radiation was administered on the 23rd day of pregnancy. No congenital malformations were noted in the offspring of the irradiated mother-rabbits, explained by the fact that irradiation was administered late in the pregnancy (last third). The bioelectric activity of the brain was investigated in 18 experimental and 15 control rabbits. Observed remote stable after-effects of antenatal irradiation in the adult rabbit are also given. Various differences were noted in the electroencephalogram of the irradiated animals. The EEG amplitude was much lower as compared to that of the normals; the frequency characteristics differed in that the higher frequencies of the EEG (over 10 cycles) and some of the lower frequencies were poorly visible resulting in a more uniform type curve. A frequency analysis of the EEG showed that, in addition to a general lowering of the amplitudes in the case of the experimental animals, a predominant impairment of the higher frequencies. EEG's of the experimental animals showed frequency spindles with greater amplitudes, often distributed in the visible region of the spectrum. EEG's of the experimental animals further showed a deterioration in the condition of the nervous system, expressed through a lowering in the stimulation and reactivity, a more frequent occurrence of paradox-type answers and an increase in the delayed action duration. The EEG of rabbits irradiated on the 23rd day of embryonic development differed from that of the normals. The former was characterized by an amplitude curve drop and change of its frequency composition, with a predominant drop of potential in the upper frequency range of the EEG spectrum. Investigations using the EEG curve reactivity method indicated a lowering of stimulation and reactivity of the EEG, and increase of delayed action, and a much more frequent occurrence of paradox-type phenomena as compared to the normals. Noted characteristics of the EEG indicated a deterioration in the nervous system and particularly of the brain cortex in the experimental animals. A drop in strength and mobility of the nerve processes was noted, with high sensitivity of the embryonic nervous system to effects of radiation. The after-effects of the radiation were long-lasting. (OTS)

32836 A STUDY OF THE INTER-CENTER RELATIONSHIPS IN THE BRAIN OF A RABBIT, IRRADIATED WITH X-RAYS DURING EMBRYOGENESIS. A. M. Ivanitskii. p.141-55 of "Vliyaniye Ioniziruyushchego Izlucheniya na Funktsiyu Vysshikh Otdelov Tsentral'noy Nervnoy Sistemy Potomstva." Moscow, Medgiz, 1961.

Electrophysiology tests of the higher central nervous system were conducted on 27 rabbits; 9 were irradiated on the 15th and 8 on the 23rd day of embryogenesis with a 400 and 300 r x ray dose, respectively. An analysis of the obtained changes in the sections of the central nervous system and their localization was carried out. The inter-center relationships were studied by creating a certain reaction in the animal connected with the simultaneous activity of the various brain structures, namely, the rousing or activation reaction of the electroencephalogram. The rousing reaction was caused by injecting adrenaline into the adult animal. Intravenous injection of the adrenaline caused changes in the rabbits encephalogram, typical of the rousing reaction. The reaction is expressed through the synchronization of the electroencephalogram of the visible region in the main rhythm. In the mobility region, both desynchronization as well as synchronization of the curve were noted. A significant increase of the adrenaline dose caused a drop or disappearance of the typical reactions, and in many cases, a shifting to spindle-like activity which, in turn, is explained by phenomena of excess inhibition. There were significant individual differences in the adrenaline doses, causing threshold and excessive effects. An assumption is made that the differences depend on the different physiological strength of the reticular centers in the various animals. (OTS)

32837 CHARACTERISTIC FEATURES OF THE STRUCTURAL CHANGES IN THE CENTRAL NERVOUS SYSTEM OF RATS, IRRADIATED WITH X-RAYS DURING EMBRYOGENESIS. N. I. Artynkhina. p.156-72 of "Vliyaniye Ioniziruyushchego Izlucheniya na Funktsiyu Vysshikh Otdelov Tsentral'noy Nervnoy Sistemy Potomstva." Moscow, Medgiz, 1961.

A study was conducted on the effects of ionizing radiation on the brain of rats irradiated on the 12th day of antenatal development, with a 200 r dose of radioactive cobalt. Destruction of the embryogenesis and the postnatal brain development was revealed. A study of the dynamics of postnatal brain development in animals irradiated on the 12th day of antenatal development showed a slowing down of the maturing of the cortex neurons in the development of the optic foramen and subcortex centers and a deceleration of the postnatal differentiation process of the cortex neurons The latter brings on dystrophy in the later stages of life and subsequent atrophy of the cortex. The occurrence and development of structural impairments in the brains of rats during the antenatal and postnatal periods of development, irradiated during the fertile period on the 18th day of antenatal development was investigated. Death of the fetal epithelium and neuroblasts surrounding it was clearly evident 6 hours after irradiation. Death of the fetal epithelium during the formation period of the deep portions of the cortex girth caused underdevelopment in the surface layers of the cerebral hemosphere cortex of the fetus, espcially in the dorso-medial portions of the cortex due to necrosis of the hemispheres. During the early period of postnatal life (1-21 days), coarse pathological changes of the nerve cells were absent in the animal's brain. The former appear after 45 and 90 days more frequently in the cortex of the cerebral hemispheres. Cytolysis and wrinkling were the most frequent forms of nerve cell changes in the cortex and vacuolization of the nerve cells in the sub-cortex formations. All the irradiated animals showed an underdevelopment and atrophy of the synoptic ends on the appendices, and intensity drop of the RNA reaction as compared to the normal productive dystrophy changes of the microgly and vascular changes. Irradiation of rats on the 18th day of antenatal development produced a significant weight lag of the brain and high fluctuations of the latter in animals of the same litter and age, as compared to the normals. The brain weight lag was mostly due to the underdevelopment of the cerebral hemispheres, primarily in the cortex. (OTS)

32838 HISTOPATHOLOGICAL FEATURES OF CHANGES IN THE CENTRAL NERVOUS SYSTEM AT LATE PERIODS OF WHITE RATS, IRRADIATED DURING EMBRYOGENESIS. M. M. Aleksandrovskaya. p.173-84 of "Vliyaniye Ioniziruyushchego Izlucheniya na Funktsiyu Vysshikh Otdelov Tsentral'noy Nervnoy Sistemy Potomstva." Moscow, Medgiz, 1961.

Baby rats were irradiated interuterinely, on the 12th day of embryonic development, with gamma rays. The mother

rat received a total dose of 200 r. A microscopic study of the brain of the animals was carried out by staining methods of nerve cells, fibers, RNA, synapses, astrocytes, oligodendrogly, microgly, and argirophyllic grains. The brain was studied at 11 and 16 months after birth. It was established macroscopically that the cortex of the cerebral hemispheres was underdeveloped; the weight of the brain in the experimental animals was 200-250 mg lighter. The subcortex formations were reduced. Hydrocephaly was noted 165 months after birth in 4 of the animals. Three groups of animals were recognized according to the degree of morphology changes. The first group was characterized by a cell rarefaction in the outer and particularly deep layers of the cerebral hemisphere cortex, resulting in destruction of the cytoarchitectony of the cortex with signs of cell devastation in the case of the experimental animals. The second group of experimental animals included 8 blind rats, surviving for 16 months. A microscopic analysis of the brain in the frontal and dorsal sections of the hemispheres showed a sharp wrinkling of the nerve cells with stopper-type growths. The blind animals were shown to have anoxic encephalopathy in the brain. Four animals, representing the third group, revealed an accumulation of translucent fluid under the hard cerebral membrane, severe atrophy of the brain, and hydrocephaly. It was established morphologically that the greatest changes take place in the animals depending not only on specific conditions of development of the neuroblasts and spongioblasts during the period of differentiation, but also on the complications occurring in the form of an increasing edema of the brain and on toxic–anoxic and exchange changes developing in the different structures of the brain. (OTS)

32839 MORPHOLOGY CHANGES OF THE CORTEX AND SUB-CORTEX FORMATIONS OF THE BRAIN IN ADULT RABBITS, IRRADIATED ANTENATALLY WITH X-RAYS. I. A. Chernyshevskaya. p.185-91 of "Vliyaniye Ioniziruyushchego Izlucheniya na Funktsiyu Vysshikh Otdelov Tsentral'noy Nervnoy Sistemy Potomstva." Moscow, Medgiz, 1961.

A morphology study was made of the cortex and subcortex formations of the brain in adult rabbits irradiated with a 400 r dose of x rays on the 15th day of antenatal development and surviving for 12-15 months. Seven animals were investigated, all of which showed cortex atrophy of the cerebral hemispheres. The following macroscopic changes revealed were underdevelopment of the cortex of the hemispheres, crust, and cerebellum expansion of the spaces of the brain tubercles with hydrocephaly in some of the animals. A microscopic investigation revealed deep dystrophic changes in the cortex expressed through destruction of the cytoarchitectony and stratification of the layers of the cortex (in different analyzers). Changes in the form of swelling, edema, and severe irreversible forms of distrophy were noted in specific and non-specific nuclei of the tubular part of the brain. Hydropathic changes of the nerve cells were particularly noted in the ventro-medial and dorso-medial nuclei of the hypothalamus in the central grey matter of the middle cerebrum. Special attention is given to the non-uniformity of changes in the non-specific formations in the various sections of the brain of different animals. It is pointed out that morphology changes, under the action of ionizing radiation, on the offspring of rabbits, were generally similar in the adult animal to those of rats irradiated in the antenatal period. (OTS)

32840 CHANGES IN THE PERIPHERAL BLOOD OF RATS SUBJECTED TO THE EFFECTS OF IONIZING RADIATION IN THE ANTENATAL PERIOD OF DEVELOPMENT. M. B. Gol'dberg. p.192-201 of "Vliyaniye Ioniziruyushchego Izlucheniya na Funktsiyu Vysshikh Otdelov Tsentral'noy Nervnoy Sistemy Potomstva." Moscow, Medgiz, 1961.

Delayed after-effects of the harmful action of radiation energy in the blood-forming system of irradiated offspring were investigated. Three groups of female rats were irradiated, on the 5th, 12th, and 18th day of pregnancy, respectively with a 200 r x-ray dose. Irradiation of the embryons on the 5th day of antenatal development – at the end of the pre-implantation period, caused wide-spread death of the animals, but the embryons which survived showed no somatic malformations. The healthy condition of the organs and systems of the survived offspring, however, was open to doubt. An assumption is made of a lag existing in the transfer from embryonic blood-formation to a normoblastic one, in rats irradiated on the 15th day of antenatal developments. The irradiation on the 12th day of pregnancy definitely showed a remote effect on the blood-forming organs of the embryons. The higher counts of the erythrocytes, leukocytes, and hemoglobin are explained by occurring hyperregeneration. The rats irradiated on the 18th day of pregnancy showed more noticeable deviations in the composition of the peripheral blood. The baby rats were born with signs of radiation sickness which last for a certain period of time. The experimental animals of all 3 irradiation periods showed a high variability in leukocyte content, indicating a high instability of the leukopoetic system in the irradiated animals. (OTS)

Radiation Sickness

32841 (AD-271679) POLAROGRAPHIC AND OTHER PHYSICAL CHEMICAL STUDIES OF ANTIRADIATION DRUGS, SUCH AS MERCAPTOALKYL COMPOUNDS IN THE REDUCED AND OXIDIZED FORM. Annual Progress Report, February 1961 to January 1962. Walter Stricks (Marquette Univ., Milwaukee). Contract DA-49-193-MD-2146. 71p.

Polarographic and physical chemical studies were made of antiradiation drugs. The polarography of 2-mercaptoethylguanidine, 2-mercaptopropylguanidine, 2-mercaptoethylamine, and 2-mercaptoethanol and their disulfides is described. The mercaptans gave an anodic wave which corresponds to the reaction $Hg + RSH \rightleftharpoons RSHg + H^+ + e$. Guanidinoethyldisulfide gave well defined reduction waves. The characteristics of these waves were accounted for quantitatively by the sequence of the following reactions: $RSSR + e + H^+ \rightleftharpoons RS^{\cdot} + RSH$, $RS^{\cdot} + e + H^+ \rightarrow RSH$, in which the first reaction is the rate- and potential-determining step. The other disulfides were reduced irreversibly at the dropping mercury electrode. A study was made of the interactions of 2-mercaptoethylguanidine, 2-mercaptoethylamine, and 2-mercaptoethanol with silver ion. Amperometric and potentiometric argentimetric titrations in alkaline medium indicated that the two former compounds give three types of complexes, $RSAg\,(RSH)_X$, RSAg and $[Ag\,(RSAg)_X]^+$ while the latter gives only one silver compound, RSAg, which is slightly soluble in water. EMF measurements at a silver electrode in mixtures of a large excess of mercaptan and silver allowed the determination of the dissociation constant of the complex $(RS)_2Ag$ for 2-mercaptoethylguanidine, 10^{-18}, and for 2-mercaptoethylamine, 8.9×10^{-19}, and the solubility product of RSAg for mercaptoethanol, 5.3×10^{-20} at 25°C. The interaction of disulfides with sulfite is discussed. The equilibrium constants of the reaction $RSSR + SO_3^{=} \rightleftharpoons RS^- + RSSO_3^-$ in alkaline medium were determined for guanidinopropyldisulfide,

aminoethyldisulfide, and hydroxyethyldisulfide, and found to be 0.016, 0.012, and 0.023 at 25°C. The interactions of cuprous ion and mercaptoethylguanidine, mercaptoethylamine, and reduced glutathione were investigated. Mixtures of cuprous ion and mercaptans were investigated polarographically in ammoniacal medium, and the dissociation constants of the complex RSCu were determined for mercaptoethylguanidine and mercaptoethylamine. Cuprous glutathionate appeared to be irreversibly reduced at the dropping mercury electrode. (auth)

32842 STUDIES ON RECOVERY FROM RADIATION INJURY. II. OBSERVATIONS ON THE EFFECTS OF IMPLANTATION OF SHIELDED SPLEEN. Yasuro Kamochi, Bunro Watanabe, Noboru Ozono, and Masanobu Tomonaga (Hiroshima Univ.). Acta Med. Nagasakiensia, 6: 1-4(Sept. 1961).

CF1 mice were exposed to a single dose of 930 r whole-body irradiation, their surgically exteriorized spleens being shielded with lead. Slices of these spleens were obtained at various intervals and implanted intraperitoneally in lethally irradiated (930 r) mice of the same strain. The 28-day survival rate in control mice not receiving spleen transplants was 2%, while that in mice receiving spleen from nonirradiated mice was 9.5%. The respective survival rates in mice receiving spleen slices 3 hr, 1, 2, 4, 7, 10, and 14 days after irradiation of the donors were 17, 29, 11, 0, 5, 43, and 31%. It is evident that spleen taken 2 to 7 days after donor irradiation is considerably less effective in prolonging survival than tissue taken at earlier or later times. The greater effectiveness of 10- and 14-day samples over all earlier samples may be explained by the radiation-stimulated increase in erythropoiesis, megakaryocytopoiesis, and granulocytopoiesis that was previously noted in shielded spleen of irradiated animals. The oxygen uptake of shielded spleen increased markedly at 2, 3, and 24 hr after irradiation. (H.H.D.)

32843 THYROID TUMORS AMONG THOSE EXPOSED TO RADIATION FROM THE ATOMIC BOMB. Chikao Harano, Hiroshi Tezuka, and Raisuke Shirabe (Nagasaki Univ.). Acta Med. Nagasakiensia, 6: 36-42(Sept. 1961).

A survey of hospitals in the city of Nagasaki revealed that of 205 patients whose thyroid glands were resected because of tumors from 1947 to 1960, 45 had histories of exposure to the atomic explosion. All subjects within 5 km of the hypocenter were included in the exposed group. The sex ratio of thyroid tumor incidence was similar in the exposed and unexposed groups, the respective female-male ratios being 6.5:1 and 5.6:1. The median age in the tumor group was 30 to 39 yr, whereas in the unexposed the incidence of tumors was spread almost equally over the 20- to 50-yr span. The percentage incidence of various types of thyroid disease in the exposed and unexposed groups was: adenocarcinoma 15.6, 10.6; papillary carcinoma 20.0, 13.8; adenoma 8.9, 1.3; nodular goiter 20.0, 18.8; nonspecific chronic thyroiditis 8.9, 5.6; and toxic goiter 22.2, 47.5. The incidence of malignant tumors was highest in those exposed at an early age; 68% of those developing such tumors were exposed before the age of 10. Occurrence of thyroid cancer was significantly higher in subjects exposed within 2 km of the hypocenter compared with the unexposed, whereas those exposed at 2 to 5 km showed no such difference from the unexposed. The pathological thyroid glands showed no histologic features that could be specifically attributed to radiation exposure. Although the number of cases studied is too small to draw definite conclusions, the results suggest that in some of these cases thyroid cancer is causally related to atomic bomb exposure. (H.H.D.)

32844 LEUKEMIA IN RADIOLOGISTS, TEN YEARS LATER; WITH A REVIEW OF THE PERTINENT EVIDENCE FOR RADIATION LEUKEMIA. Herman C. March (Univ. of Pennsylvania, Philadelphia). Am. J. Med. Sci., 242: 137-49(Aug. 1961).

A statistical analysis of deaths from leukemia in 11 radiologists from 1949 to 1958 and in nonradiological physicians in the United States showed a rate 4 to 5 times greater in radiologists. The incidence of leukemia deaths in radiologists (3.23%) during this decade is less than the comparable figures found for the preceding 20 yr (4.68%). The incidence in nonradiological physicians was 0.51%. The frequency has thus decreased from about 9 times the incidence in nonradiological physicians, but this still appears statistically significant. It is anticipated that this differential will tend to diminish still further, but will not entirely disappear, as protective measures improve. There appears no doubt of the causal relation of ionizing radiation with some cases of leukemia. A review of the major evidence for this relation is presented. The most positive evidence comes from the experimental laboratory, from atomic bombing data, from the studies in radiologists, and from after-effects of roentgen therapy in ankylosing spondylitis. Suggestive evidence comes from irradiation of the infantile thymus, and doubtful evidence from therapeutic use of radioactive iodine and with antenatal fetal diagnostic irradiation. The majority opinion holds that the evidence points toward a linear dose-response relation in radiation leukemogenesis, but there is good authority also for the concept of a nonlinear relation. As to whether there is a linear relation for small doses, or whether there is a threshold dose, has yet to be determined. (H.H.D.)

32845 STUDIES ON LIPID BIOSYNTHESIS IN THE ISOLATED LIVER OF THE RAT: EFFECT OF PERFUSION OF BLOOD OF IRRADIATED ANIMALS. N. Pacilli and M. Bisiani (Università, Milan). Atti accad. med. lombarda, 16: 6-8(Jan.-Mar. 1961).

Formation of lipids in isolated liver was studied by their incorporation of acetate-1-C^{14} during perfusion of the liver with heparinized blood of normal and irradiated rats. Blood was obtained 24 hr after irradiation with a single dose of 3500 r. Synthesis of both cholesterol and fatty acids was significantly stimulated by blood of irradiated animals. The mean specific activities with normal and irradiated blood, respectively, were 1185 and 2290 cpm/mg for cholesterol, and 387 and 589 for fatty acids. The incorporation of C^{14} into lipids of the perfusing serum was also greater 4 hr later with irradiated blood; the respective values of specific activity were 421 and 1110 cpm/mg for cholesterol, and 65 and 138 fatty acids. The results are in accord with previous findings that irradiation of rats causes accumulation of lipid in the liver in the intact animal. (H.H.D.)

32846 COMPARISON OF THE EFFECTS OF X-RADIATION ON THE ELEVATION OF THYMIDINE KINASE AND THYMIDYLATE SYNTHETASE DURING LIVER REGENERATION. Richard E. Beltz (Loma Linda Univ., Calif.). Biochem. Biophys. Research Communs., 9: 78-83 (Sept. 25, 1962).

Investigations were made to determine if exposure to x radiation between 14 and 17.5 hr after surgery might prevent the onset of DNA synthesis in regenerating liver by interfering with the accumulation of thymidylate synthetase. Male albino rats were partially hepatectomized, fasted, and exposed to x radiation. One group was exposed 6 to 7 hr after partial hepatectomy and another group at 15 to 16 hr. The rats were sacrificed and a 60,000 xg liver supernatant fraction was prepared in isotonic KCl. Each

supernatant fraction was assayed for thymidine kinase, as well as thymidylate (TMP) synthetase. Kinase activity in the livers of rats irradiated 6 to 7 hr postoperatively was less than 3% of the kinase activity in the livers of unirradiated controls. In the livers of rats exposed to x radiation 15 to 16 hr postoperatively, kinase activity approached 15% of that of unirradiated controls. The activity of TMP synthetase in livers of irradiated rats averaged 75% of that in livers of unirradiated controls, and the effect of early irradiation appeared to be somewhat less than the effect of late irradiation. The failure of early or late x-radiation doses to prevent the elevation of TMP synthetase ruled out the possibility that prevention of the initiation of DNA synthesis by prior irradiation could be attributed to interference with the activity of TMP synthetase. (M.C.G.)

32847 THE RECOVERY OF MYELOPOIETIC CELLS AFTER IRRADIATION: A QUANTITATIVE STUDY IN THE RAT. E. V. Hulse (Medical Research Council, Radiobiological Research Unit, Harwell, Berks, Eng.). Brit. J. Haematol., 7: 430-41(Oct. 1961).

Rats were irradiated with 100, 200, and 400 r, and bone marrow myeloid cells were counted 14, 42, or 70 days later. After the initial depletion, all the neutrophilic cells of the blood and bone marrow showed a temporary increase in numbers at about 1 week after irradiation. A second fall in cell numbers followed during the second week and, even though an increase in numbers occurred during the third week, later values were frequently below normal. Promyelocytes showed a similar pattern of recovery but the blast cells, after regaining their normal numbers during the second week, did not show any subsequent fall. The eosinophil series underwent temporary and sometimes marked increases in numbers but these increases did not coincide with those of the neutrophil series. Recovery was also incomplete. The results confirm the existence of a temporary or abortive recovery and also suggest that observations over a fairly long period, probably several months, are necessary before recovery after a single dose of irradiation can be said to be complete. The time taken for myelocytes to mature into segmented neutrophils was about 2 days; however, recovery after irradiation may not be a reliable method of assessing maturation time. Two major objections are: (1) irradiation damage may alter the rate of maturation of a group of cells and (2) the time taken for cells to repopulate a marrow which was very depleted of cells may not necessarily be the same as the maturation time in the normal animal. (H.H.D.)

32848 TURNOVER STUDIES WITH ^{59}Fe IN LETHALLY IRRADIATED RATS TREATED BY BONE-MARROW TRANSPLANTATION. Mostafa Khalil and Hassan K. Awwad (Univ. of Alexandria, Egypt). Brit. J. Haematol., 8: 180-6(Apr. 1962).

Fe^{59} turnover was studied in normal and lethally irradiated rats with and without intravenous bone-marrow treatment. An intensified activity in both the spleen and bone marrow was maintained up to 2 months after irradiation. Development of this activity proceeded at about the same pace in both organs and they maintained nearly the same relative activity as in normal unirradiated animals. These findings are in contrast to the biphasic pattern of erythropoietic recovery in the rat after sub-lethal whole body irradiation with or without hind-limb shielding. Under such conditions, the recovery of splenic erythropoiesis preceded that of the irradiated bone marrow, though an abortive erythropoietic activity occurred in the unshielded limb. Even in a rat strain in which no splenic erythropoiesis was normally found, erythropoietic activity developed after irradiation with or without hind-limb shielding as well as after intra-peritoneal injection of bone-marrow homogenate. In a lethally irradiated untreated group studied 7 days after irradiation, the Fe^{59} distribution curves suggest the occurrence of a slight degree of erythropoietic recovery shown by a higher Fe^{59} bone-marrow curve, a slight increase in the circulating labelled red cells, and some degree of mobilization of the hepatic Fe^{59}. The bone-marrow curve showed a higher peak compared with the corresponding curve at 4 days, but the subsequent release of Fe^{59} was very slow. This would be explained either by a relative deficiency of late forms of red-cell precursors which are very radiosensitive or by a lag in the maturation and release of these late forms. The data indicate that the therapeutic effect of bone-marrow transplantation was simply the provision of a greater number of functioning erythropoietic cells in the normal sites than in the intact animal. This would enhance erythropoietic recovery without any localization in ectopic sites, and no ectopic foci of erythropoiesis were demonstrated. (H.H.D.)

32849 THE EFFECT OF IONIZING RADIATION ON NUCLEIC EXCHANGE IN FEMALES AS RELATED TO THE NUMBER OF MALES AND FEMALES IN THE PROGENY. V. N. Shreder (Severtsov Inst. of Animal Morphology, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 145: 1160-2(Aug. 11, 1962). (In Russian)

Female rabbits were subject to x-ray irradiation, and then crossed with normal rabbits. The female rabbits were given whole-body doses of 50 and 250 r, and local doses of 25 and 75 r in the region of the ovaries. The content of alkali phosphatase, DNA, RNA, and of oxidative activity (the rate of oxidation of the leucobase thiomine by blood plasma) were determined before irradiation, and on the 10th day after irradiation. It was found that the activity of alkali phosphatase in blood serum drops sharply, the content of DNA and RNA rises, and the oxidative activity of the blood drops. With a local dose of 25 r and mating on the 14th day after irradiation, the progeny from the irradiated females and normal males showed 86.7% males as compared to 48% males in the controls. With a higher local dose of 75 r, an irreversible sterility was observed (17 females born dead, and two males born alive in the progeny). With a whole-body dose of 50 r, and mating on the 14th day after irradiation, the percentage of males in the progeny was high (81%). With a whole-body dose of 250 r, and mating on the 14th day after irradiation, the percentage of males was 100% (34 males and no females). The irradiated females then entered a period of temporary sterility, and after about two months, began to bear young again with a high percentage of males (94.7% males when mating took place 45 days after irradiation, and 78.6% males when mating took place 75 days after irradiation. (TTT).

32850 USE OF CHEMICALS TO PROTECT INTESTINES FROM INJURY BY X RADIATION. Emanuel E. Schwartz (Albert Einstein Medical Center, Philadelphia). J. Albert Einstein Med. Center, 10: 5(Jan. 1962).

Whole-body x radiation of mice at a level greater than 600 r caused impairment of the absorption of iodinated oleic acid 2 days after exposure. There was no decrease in the absorption of I^{131}-labeled serum albumin at levels up to 1400 r. Although irradiation caused increased gastric retention, this was apparently not responsible for the change in fatty acid absorption. Administration of 2-mercaptoethylguanidine before irradiation, either orally or intraperitoneally, prevented the deleterious effect on absorption and gastric emptying. (H.H.D.)

32851 MECHANISM OF ACTION OF A RADIATION PROTECTIVE AGENT. Bernard Shapiro (Albert Einstein

Medical Center, Philadelphia). J. Albert Einstein Med. Center, 10: 8(Jan. 1962).

The radiation protective agent AET (S-(2-aminoethyl) isothiuronium bromide) was labeled with S^{35} and studied in 3 different systems. In the 1st system, AET was irradiated in aqueous buffered solutions, and the radiation products were isolated and identified. In these irradiated solutions, oxidation products of the sulfhydryl (MEG) and disulfide (GED) forms of AET, namely, the sulfonic acids and sulfate, were observed. The 2nd system involved the study of the interaction of MEG and GED with proteins. Protein-binding of these protective agents was noted in a series of protein solutions, the major bond between the protein and MEG being the mixed disulfide bond. Irradiation of protein solutions containing MEG and GED increased the protein-binding of these agents. The 3rd system studied was the distribution and metabolism of AET in mice in vivo. The major form of AET in the mouse was observed to be the protein-bound form. This form correlated best with conditions resulting in protection of the animal against radiation death. (H.H.D.)

32852 PROTECTIVE EFFECTS OF VITAMIN P AGAINST GAMMA IRRADIATION. Tsu-Chi Chow (National Taiwan Univ., China). Mem. Coll. Med. Natl. Taiwan Univ., 6: Nos. 1-2, 145(Mar. 1960). (In Chinese)

The kinds of vitamin P, time interval and route of administration, doses and concentration of drug, and source of radiation were considered as the factors of varying results. Experiments on young adult D.D. mice showed less than 50% mortality with whole-body irradiation of $LD_{100/28}$. Cobalt-60 was used as the source of gamma rays. The factors are 50 cm skin source distance, 10 × 15 cm in field and 63.7 γ/min output. During irradiation, mice were in prone position. The LD_{100} was around 970 γ/28 days. Thereafter, 10 mice were given hesperidin (vitamin P), 5-7-3-trioxy-4'-methoxyflavanone-7-rhamnoglucoside, 0.025 mg in 0.1 cc intravenously every day for three days. The interval was 48 hours, 24 hours, and 15 minutes before irradiation with a dose of 970 γ. There were 6 survivals in the hesperidin group and none in the control group after 28 days. Weight change in the spleen was remarkable. There was no change in the hesperidin group and one-sixth of normal weight in the control group after LD_{100}. (auth)

32853 THE PHYSIOPATHOLOGIC EFFECTS OF RADIATIONS DUE TO NUCLEAR EXPLOSIVES. C. Paoletti (Inst. of Gustave-Roussy, Villejuif, France). Pathol. Biol. Semaine Hop., 10: 1213-25(July-Aug. 1962).

The effects of various types of radiation on biological systems are reviewed. (H.H.D.)

32854 CORRELATION BETWEEN THE MAGNITUDE OF THE OXIDATION-REDUCTION POTENTIAL OF THE HEMOLYMPH OF THE CRICKET, AND THE RADIOSENSITIVITY OF THE CRICKET. G. V. Sumarukov (Moscow Univ.). Radiobiologiya, 2: 374-7(1962). (In Russian)

Native crickets (Gryllus domesticus L) were irradiated in groups of 20 with Co^{60} gamma rays in the presence of air and in a nitrogen atmosphere. Separate groups were injected with free cysteine (0.6 mg/g) or with the hydrochloride cysteine salt (0.2 mg/g) as a protective agent, and were irradiated under the same conditions. The LD_{50} dose (dose causing 50% deaths) was taken as a measure of the radio-resistance. A microplatinum electrode (diameter 0.1 mm, length 2 mm), inserted in the hemolymph of the cricket, was used to measure the oxidation-reduction potential Eh, which would vary as a result of the induced respiratory hypoxia due to lack of oxygen or as a result of the injection of the protective agent. The LD_{50} dose was found to be 4200 r for irradiation in air without use of a protective agent, 6750 r for irradiation in air with the use of cysteine as a protective agent, 9900 r for irradiation in nitrogen with no protective agent, and 11,900 r for irradiation in nitrogen with cysteine as a protective agent. The protective effects of cysteine, and of the hypoxia induced by replacing air with nitrogen were found to be additive in this case. The redox potential went from +140 millivolts for the unprotected insects (LD_{50} dose of 4200 r) to −185 millivolts for the insects irradiated in nitrogen with the injection of free cysteine (LD_{50} dose of 11,500 r). It is hypothesized that a high concentration of various reducing agents are produced in the cell by removing oxygen and by injection of cysteine, and these reducing agents react with peroxide formed by radiation. As a consequence, there is less damage to vital cell components. (TTT)

32855 THE EFFECT OF POLYAMINES ON THE CATALASE ACTIVITY OF THE BLOOD OF IRRADIATED ANIMALS. O. I. Smirnova. Radiobiologiya, 2: 378-82(1962). (In Russian)

Although a drop in catalase activity is observed on irradiating an animal, administration of catalase is ineffective as a protective agent against irradiation. Iron complexes of triethylenetetramine (TETA) were found to be effective in protecting mice from the toxic effects of hydrogen peroxide. These amines can destroy hydrogen peroxide similarly to catalase. A dose of 400 mg/kg body weight of 10^{-3} to 10^{-4} M TETA-Fe^{+2} complex showed a marked increase in the number of survivals of white mice given a dose of 550 r as compared to a group of untreated controls. Three series of experiments on mice, white rats, and dogs showed an increased level of catalase activity, or at least no drop in activity, in the blood of the irradiated animals. The high level of catalase activity in the blood of the irradiated animals was correlated with the increase in survival at a confidence level of 98 to 99%. In all probability, the "catalase" mechanism plays a definite role in the pathogenesis of radiation sickness. (TTT)

32856 X-RAY-INDUCED CHANGE IN THE LEUCOCYTE REACTION. M. I. Ul'yanov. Radiobiologiya, 2: 395-400(1962). (In Russian)

Three dogs were subjected to a light electrical skin shock, and three to a heavy electrical shock, in order to induce an increase in the leukocyte blood count as a conditioned or unconditioned, defensive reflex action. The conditioned reflex was stimulated by applying the electrical shock five seconds after starting a metronome. The dogs were subjected to an intensive preliminary blood study. A typical neutrophilic leukocytosis was observed with both the conditioned and the unconditioned defensive reflexes within five minutes after application of the electrical skin shock. The leukocyte reaction was lacking or inverted on irradiating the dogs with an x-ray dose of 600 r. Even with doses of 3 and 50 r, the typical leukocyte reaction was absent, or considerably distorted. Only 5 to 6 weeks after irradiation, was a normal leukocyte reaction observed. The return of this reflex can be considered as a sign of complete recovery from the effects of irradiation. The reflex reactions of the blood can be considered as being very "radiosensitive." This reflex reaction can serve as an early, diagnostic test of radiation sickness. (TTT)

32857 SEX DIFFERENCES IN RADIOSENSITIVITY. S. N. Aleksandrov and K. F. Galkovskaya (Central Research Inst. of Medicinal Radiology, Leningrad). Radiobiologiya, 2: 401-5(1962). (In Russian)

The death rates of ordinary white female mice and male mice under various irradiation conditions were compared for various intervals after the irradiation. The mice were

given a single, Co^{60}, γ dose of 800 r, four doses of 200 r at intervals of one week, and four doses of 200 r at intervals of a month. With a single dose of 800 r, the death rate of the females (52%) was greater than the death rate of the males (44%). On fractionating the 800 r dose in four parts with intervals of one week between doses, the death rates of the males and females are almost the same (6.4 and 8%, respectively). In this case, the death rate of the females during the critical period one month after the irradiation was clearly lower than after a single dose, while the death rate of the males was not affected for this period by fractionating the dose. On increasing the interval between doses to one month, the death rate of the males also becomes smaller. It is believed that the primary damage caused by radiation is the same for males and females. Any sex differences in radiosensitivity must be due to the superior ability of the female to repair the radiation damage. (TTT)

32858 FEATURES OF A NUMBER OF EARLY REACTIONS TO BURNS INFLICTED BY FIRE ON RATS IRRADIATED AT VARIOUS DOSES. A. K. Arnautov, Sh. A. Burshtein, V. S. Genes et al. (Inst. of Medical Radiology, Kharkov). Radiobiologiya, 2: 406-13(1962). (In Russian)

Rats were given x-ray doses of 300, 600, 900, and 1200 r. Immediately after irradiation, a burn was inflicted on a 6 × 4 cm area on each side of the back by exposure to a gas burner for 10 seconds. Tests were made on various functions of the organism including the following: the state of the peripheral motor nerves, sensitivity of the back and thigh nerves, the white blood count, globulin fraction, clotting time of the blood, DNA and RNA contents in the blood and liver, total nitrogen and phosphorous, etc. The results of these tests were subjected to statistical treatment. The following variants for the reaction to burns in irradiated animals can be distinguished: 1) reaction to burn is the same as with unirradiated animals, 2) removal of the burn reaction, 3) appearance of a new burn reaction, 4) additivity of the reactions to burn and to irradiation, 5) intensification of the burn reaction because of irradiation, 6) mutual suppression of the burn and irradiation reactions, and 7) inversion of the burn reaction. Reactions 2, 4, 5, and 7 are encountered most frequently. The reactions to burn 5 days after irradiation differ substantially from the distribution of the reactions to burn 3 days after irradiation. Frequently, the reactions to burn do not depend on the dose. The results obtained for one irradiation dose are unreliable very often on being extrapolated to another irradiation dose. The results show that the reaction to burn by irradiated animals depends not only on the dose and time after irradiation, but also on the nature of the reaction under investigation and the mechanisms for injury to the organism by radiation and by burn. (TTT)

32859 THE EXCRETION OF DESOXYCYTIDINE FROM THE URINE OF RATS INFECTED WITH Po^{210}. M. S. Uspenskaya. Radiobiologiya, 2: 418-23(1962). (In Russian)

White male rats were inoculated with 0.05 mc/kg and 0.10 mc Po^{210}/kg of body weight. The total desoxyribose (Dische-positive substances) was determined on the 1st, 3rd, 6th, 9th, and 13th day after inoculation. The desoxycytidine content was determined by paper chromatography. The content of Dische-positive substances was found to have increased by 20 to 25% on the 3rd, 6th, and 9th day after inoculation with 0.1 mc Po^{210}/kg. The content of Dische-positive substances was normal with a dose of 0.05 mc Po^{210}/kg of body weight. The excretion of desoxycytidine was increased by 37% on the first day, by 52% on the 3rd day, and by 14% on the 6th day after injection of Po^{210}. The amount of excreted desoxycytidine did not depend on the Po^{210} dose, or on the quantity of urine excreted. Dosage with 0.1 mc Po^{210} per kg body weight resulted in a 20 to 25% decrease in urine output for the first few days after inoculation, a return to normal on the 3rd day, and an increase of 20 to 25% on the 6th day. Starvation of the rats on the days that the urine was collected (1st, 3rd, 6th, 9th, and 13th) did not have any effect on the amount of Dische-positive substances excreted in the urine. (TTT)

32860 CHANGES IN THE METHIONINE–CARBON-14 METABOLISM IN CALCIFIED TISSUES DURING ACUTE RADIATION SICKNESS. A. A. Prokhonuchkov (Medico-Stomatological Inst., Moscow). Radiobiologiya, 2: 424-8 (1962). (In Russian)

Injury to the mineral metabolism is one of the most important pathogenic factors in the development of radiation injury; in particular it is also established that the metabolism of C^{14}-labeled glycine is also disturbed, (Radiobiologiya 1: 340(1961)). This work was extended to include the metabolism of C^{14}-labeled methionine under the same experimental conditions, using inbred rats exposed to a single, whole-body radiation of 50 r. The animals were killed 1 to 50 days after the exposure. It was found that within 1 to 30 days the methionine metabolism is strongly depressed. The thighs and to a lesser extent the teeth of the irradiated animals exhibited the most marked reduction in the incorporation rate of methionine. After 50 days the methionine content of the exposed animals approached that of the control group; this normalization of the metabolism coincided with the initial stages of the regenerative processes in the calcified tissues. It was concluded that the calcified tissues are not as radiosensitive as it was assumed previously. (TTT)

32861 THE ROLE OF HUMORAL FACTORS IN THE DEVELOPMENT OF RADIATION-INDUCED CHANGES IN THE MAXILLARY SYSTEM. A. A. Prokhonuchkov and V. V. Panikarovskii (Medico-Stomatological Inst., Moscow). Radiobiologiya, 2: 429-33(1962). (In Russian)

Cases of radiation injury, such as radionecrosis of the jaw, were previously reported in the literature when the damaged tissue was not exposed directly to x radiation. In view of the importance of the complications due to radiation effects after x-ray therapy, the mechanism of the indirect action of ionizing radiation on the tissues of the maxillary system was investigated making use of parabiosis. Three sets of experiments were carried out on 21 pairs of parabionts and 84 individual white rats, exposing the left parabiont to 600, 700, or 1000 r of x radiation. It was found that various changes, such as plethora and edema of the mouth, hyperkeratolysis, necrotic ulceration, etc., take place in the maxillary system of the unirradiated parabionts. These changes depended greatly on the dose to which the other parabiont was exposed; the largest effect was noted 15 days after exposure to 1000 r. It is thus shown that the humoral factor is of great importance in the development of the radiation injury of the jaws and teeth. (TTT)

32862 THE EFFECT OF IONIZING RADIATION ON THE ANTITOXIC AND ANTIMICROBIAL IMMUNITY. O. V. Emel'yanova and E. A. Geintse (S. M. Kirov Military Medical Academy, Leningrad). Radiobiologiya, 2: 434-6(1962). (In Russian)

An attempt was made to clarify the effect of ionizing radiation on the antimicrobial and the antitoxic immunity of animals after vaccinating them with a still experimental, complex vaccine adsorbed on Al hydroxide. The vaccine contained the antigens of dysentery and typhoid fever bacteria and the anatoxins of botulin, gas gangrene, and teta-

nus. The twice vaccinated chinchillas were exposed to a sublethal dose of 600 r of Co^{60} γ rays during the immunity period, 10 days after the vaccination. It was found that this exposure did not affect the antitoxic immunity. After revaccination, a decrease of the antitoxin content to half of its value was noted in some animals. Irradiation of mice with 450 r of x rays 10 days after the revaccination resulted in a similar reduction of the antimicrobial activity. Thus, previous immunization increased the resistance against harmful radiation effects. (TTT)

32863 CHANGES IN THE RESPONE OF THE BRAIN BLOOD VESSELS TO ADRENALIN, ACETYL CHOLIN AND HEXONIUM AFTER WHOLE-BODY EXPOSURE TO IONIZING RADIATION. R. M. Lyubimova-Gerasimova. Radiobiologiya, 2: 455-60(1962). (In Russian)

Changes in the sensitivity of the receptor organs, synaptic groups, and the microstructure of the nerve cells play an important role in the radiation injury of the central nervous system. The effect of materials such as adrenalin and acetyl cholin which influence the tone of the brain vessels must be determined together with ganglion-inhibiting action of hexanium, in order to obtain a clearer understanding of these processes. For this reason, the flow rate of the blood in the brain vessels of the rabbits used for the tests was measured by means of thermoelectrodes placed in openings in the parietal bones of the skull, recording simultaneously the ear temperature of the animals by means of a resistance thermometer. After exposing the animals to 1000 r of radiation, it was found that the reactivity of the brain vessels toward adrenalin and acetyl cholin changes; differences were also noted in the behavior of the brain vessels toward hexonium when the vegetative ganglions and motor-vascular centers are blocked. It was concluded from these experiments that the neuro-humoral regulation of the tone of the brain vessels is affected by exposure to ionizing radiation. (TTT)

32864 BLOOD PROTEIN FRACTION CONTENT AND THE STATE OF THE ANTITOXIC FUNCTION OF THE LIVER OF ANIMALS EXPOSED TO REPEATED DOSES OF X-RAYS. V. N. Slavnov (Inst. for the Professional Development of Physicians, USSR). Radiobiologiya, 2: 461-7 (1962). (In Russian)

The effect of previous exposure of test animals to sublethal doses of radiation on subsequent exposures was investigated by examining changes in the blood protein fraction and the antitoxic activity of the liver. One group of the male rabbits was exposed to a single lethal dose of 1200 r, the second to a sublethal dose of 800 r, followed by a lethal dose $2\frac{1}{2}$ months after the first irradiation while a third group received 2 doses of 450 each, followed by a lethal dose 4 weeks or $2\frac{1}{2}$ months later. Results indicated that exposure to multiple doses leads to a reduction of the total protein, albumin, and gamma-globulin fractions and to an increase of the alpha- and beta-globulin fractions. The quantitative changes of the protein fraction of the blood and the antitoxic function of the liver depend on the dose rate and on the time elapsed since the appearance of radiation injury: the larger the radiation dose, the more marked will be the depression of the blood protein fraction and of the antitoxic function of the liver. Animals exposed to 2 doses of 450 r each + a lethal dose 4 weeks later died faster than those receiving a single lethal dose; those exposed to 450 or 800 r followed by the lethal dose $2\frac{1}{2}$ months later exhibited acute radiation sickness and survived for 10 to 12 months, presenting a lesser degree of depression of the above mentioned functions. These parameters are considered good indicators of the acute radiation sickness. (TTT)

32865 RELATION BETWEEN THE RADIOSENSITIVITY OF THE NERVOUS SYSTEM AND THE RADIATION SICKNESS OF ANIMALS. N. G. Darenskaya and A. B. Tsypin. Radiobiologiya, 2: 468-72(1962). (In Russian)

Knowledge of the original functional status of the central nervous system and typical characteristics of higher nervous activities is important for the study of the effect of radiosensitivity of individual organs on the over-all biological effect of the radiation. This problem was investigated by comparing the injury caused in rabbits by a subsequent irradiation with the radiation sensitivity of the central nervous system. This latter property was estimated from the bio-current of the brain when either the head or the trunk of the animal was irradiated. The total dose used was 390 r to the head or 39 r to the trunk of γ radiation, exposing the animals subsequently to an integral dose of $LD_{50/45}$ = 500 r. Comparison of the radiosensitivity of the central nervous system and the injury suffered by the animal did not reveal any direct correlation. As a general rule, it can be stated that animals possessing higher radiosensitivity exhibited a lesser degree of radiation injury. (TTT)

32866 THE NATURE OF THE RADIOPROTECTIVE EFFECT OF NARCOTIC DRUGS ON THE SENSITIZING PROPERTY OF OXYGEN. V. P. Paribok, G. F. Krupnova, and K. I. Pravdina (Inst. of Cytology, Academy of Sciences, Leningrad). Radiobiologiya, 2: 473-80(1962). (In Russian)

M. Ebert et al. (Nature 181: 613(1958)) observed that seedlings of the bean Vicia faba, exposed to radiation in gaseous media containing air and inert gases under pressure, exhibited a lesser degree of radiation injury than those irradiated in air. The reduction of the injury, judged on the basis of the growth rate of the main root, was a function of the pressure. These results are not due to the chemical behavior but to the over-all physicochemical properties of the gases. It is of interest to note that all the gases tested, N_2, H_2, He, Ar, Kr, Xe, N_2O, CH_4, and $(CH_2)_3$ (cyclopropane) possess narcotic properties; similar although less marked effects were observed by using nongaseous narcotic agents such as alcohol and barbiturates on mammals. This was further investigated by exposing Vicia faba seedlings to x radiation in the presence of gaseous and nonnarcotic agents, using a calorimetric bomb to contain the gases under pressure. It was found that hydrocarbons, freon, and nongaseous narcotics such as alcohol, ether, and acetone exert a less marked protective action than the inert gases and nitrogen. The protective action, determined from their participation in the oxygen-dependent portion of the radiation injury, decreases with increasing molecular volume. It is assumed that the protective action is due to the competition of the narcotics' molecules with oxygen in the pores of the radiation-sensitive polymers. (TTT)

32867 THE GENETIC RADIOSENSITIVITY OF THE GUINEA PIG. E. D. Plotnikova, S. I. Strashenenko, and N. I. Shapiro (Inst. of Biological Physics, Academy of Sciences and Academy of Medical Sciences, USSR). Radiobiologiya, 2: 481-4(1962). (In Russian)

Previous investigations of the authors (Radiobiologiya 1: 93(1961) No. 1) concerning the dependence of the frequency of dominant lethal mutations on the dose rate of the x radiation to which rabbits, rats, and mice were exposed, was extended to include a similar study of guinea pigs. The gonads of the male animals were locally irradiated at 300, 450, and 750 r; the animals were then mated, killing the females within the 30th and 40th day of the ensuing pregnancy. The number of corpora lutea, the place of implanta-

tion, and the embryos were determined and used for calculating the losses of the offspring as the result of dominant lethal mutations in the spermatozoa. Results indicated great variations in the genetic radiation sensitivity of these related animals: the frequency of the occurrence of dominant lethal mutations was considerably lower in the guinea pig than in mice, rats, or rabbits. Further studies are needed for clarifying the meaning of chromosome aberrations due to radiation. (TTT)

32868 THE EFFECT OF RADIOACTIVE PHOSPHORUS-32 ON PHOTOSYNTHESIZING PURPLE SULFUR BACTERIA. V. A. Lambina (Inst. of Microbiology, Academy of Sciences, USSR). Radiobiologiya, 2: 492-6(1962). (In Russian)

The purple sulfur bacterium which utilizes solar energy for building its cell structure from the carbon of CO_2, is suited for studying the effect of ionizing radiation on photosynthesis. This approach was used in studying the effect of radiation from P^{32}, determining the ability of irradiated Chromatium vinosum to accumulate CO_2. As radiation source, $Na_2HP^{32}O_4$ salt was used. The activity of the medium at the time of the tests was kept at definite values between 0.0055 and 55 microcurie/100 ml. Results showed that radiation from P^{32} in doses from 0.0055 to 5.5 microcurie/100 ml stimulates the cellular division of the bacteria causing an increased biomass in the cells; doses from 11 to 55 microcurie/100 ml depress these processes. Comparison of tests carried out in darkness and under illumination that the bacteria which accumulate CO_2 autotrophically do not make use of the radiation emitted by P^{32} as an energy source in doses from 0.0055 to 55 microcurie/100 ml. (TTT)

32869 INFLUENCE OF THE GROWTH RATE OF PLANTS ON THEIR RADIOSENSITIVITY. T. G. Mamedov (Lomonosov State Univ., Moscow). Radiobiologiya, 2: 497-501(1962). (In Russian)

Assuming that individual variations of the radiosensitivity of plants are due to differences in the growth rate, similarly to animals cells which are more easily injured by radiation when undergoing rapid division, the correlation between the changes in the growth rate of Vicia faba and its growth rate was investigated. Experimental details of the irradiation technique with a Co^{60} source were described in a previous publication (Tsitologiya 2: 175(1960) No. 2). From the distribution curve of the growth of the fine roots and the radiosensitivity curve of the seedlings it was deduced that there is a correlation between these factors: the radiosensitivity of plants of the same age is a function of their individual growth rate. The growth rate, the intensity of the cell division, is thus a criterion of the degree of the radiation sensitivity. (TTT)

32870 INVESTIGATION CONCERNING THE EFFECT OF X RADIATION ON THE GROWING LARYNX OF RABBITS. Theophil Hornykiewytsch and Joachim Drabe (Universität, Giessen, Ger.). Strahlentherapie, 118: 518-25 (Aug. 1962). (In German)

Single irradiation of the infantile larynx of the rabbit with 500 r causes a slight growth inhibition of the larynx. Administration of 1000 r shows the greatest effect which cannot be increased significantly by doubling the radiation dose. The radiation sensitivity of the growing larynx is of a dose range which was determined for the epiphyses of the bone skeleton or for the lens by means of clinical observations and experimental studies. The radiation dose of 500 r single irradiation was considered as a limit value, beyond which potential damage of the growing larynx begins. (auth)

32871 CLINICAL OBSERVATION OF THE IRRADIATION OF PATIENTS WITH CARCINOMA UNDER SPECIAL CONSIDERATION OF BLOOD STATUS AND WEIGHT. Julius Weishaar and Wolfgang Losgar (Universitäts-Frauenlinik, Erlangen/Nuremberg). Strahlentherapie, 118: 538-49(Aug. 1962). (In German)

Clinical investigations about the behavior of blood composition and weight are discussed in connection with radiation therapy. Especially, the effects of short-time x-ray irradiation and fractionized x-ray irradiation added to a high radium dose are compared. (auth)

32872 RESULTS OF A PRENATAL WHOLE-BODY ROENTGEN IRRADIATION ON THE HEMATOPOIESIS OF YOUNG RATS. Ursula Reincke (Chirurgische Universitätsklinik, Freiburg i. B.). Strahlentherapie, 118: 570-80 (Aug. 1962). (In German)

A study was made of 360 young animals born at the normal time after whole body x irradiation of 42 pregnant Albino rats (on the 18th day of pregnancy) with 270 r. Almost half of the newborn died within the first week as a result of the radiation syndrome. Hemoglobin, number of erythrocytes, leukocytes, and thrombocytes were determined in 175 young animals during the period of development, and smears of blood and bone marrow were differentiated. The blood cell count dropped to minimal values on the 4th and 8th day of life (8 to 12 days after irradiation). Regenerative events in the bone marrow started on the 3rd day of life, in the blood on the 8th to 10th day of life. The average values of normal young animals at the same age (except the peripheral granulocytes and lymphocytes counts) were reached by the survivors by the second half of the first month. Furthermore, the erythrocytes showed an excessive regeneration with a peak on the 50th day of life. It was observed that surviving young animals show a good regeneration ability of the hematopoietic system, which possibly may be superior to the one of the adult animals. (auth)

32873 OBSERVATION OF THE HYDROGEN SULFIDE GENERATION BY TUMOR IRRADIATION. Gunther Barth and Herbert Graebner (Universitätsklinik, Erlangen/Nuremberg) and Universität, Giessen, Ger.). Strahlentherapie, 118: 581-5(Aug. 1962). (In German)

It could be proven by animal experiments using 90 white mice that hydrogen sulfide is produced in ulcerated tumors under the influence of x rays. (auth)

32874 INVESTIGATION OF THE RADIATION SENSITIVITY OF CATALASE. Erwin Magdon (Institut für Medizin und Biologie, Deutschen Akademie der Wissenschaften, Berlin). Strahlentherapie, 118: 586-604(Aug. 1962). (In German)

The radiation sensitivity of catalase was found to depend upon the oxygen content of the irradiated enzyme solution and the dose rate of the radiation used. This different radiation sensitivity is caused by the hydrogen peroxide, which is produced in different amounts depending upon the oxygen content and the dose rate. The protection effect of hydrogen peroxide on the radiation induced inactivation of the catalase is caused by the formation of reversible catalase-hydrogen peroxide-complexes. It is assumed that the biological effect of the ionizing radiation is influenced by catalase, which destroys by formation of the catalase-hydrogen peroxide-complex the OH- and HO_2-radicals. (auth)

32875 INVESTIGATION OF THE MECHANISMS OF THE RADIATION PROTECTION EFFECTS OF CYSTEINE. Henry Albers, Helmut Harth, Otto B. Genius, and Hans Chr. Kaerner (Universität, Mainz). Strahlentherapie, 118: 605-18(Aug. 1962). (In German)

The type of binding of the radiation protection substance cysteine to a biological metalloenzyme-system is demonstrated using alkaline phosphatase, a magnesium-zinc-proteide. The molecules of cysteine as well as the molecules of the substrate are bound to the zinc-ion complex as the "active" group of the enzyme; they are able to displace each other from their binding. The proven strong binding of cysteine in the complex cysteine-zinc-phosphatase is the presumptive basis for the radiation protection of phosphatase and for the presumptive reaction mechanisms responsible for damaging of the enzyme by ionizing radiation. The possible importance of the model experiment for other natural metal containing systems as well as for the radiation resistance during hibernation is discussed. (auth)

32876 AUTOLOGOUS AND ISOLOGOUS BONE MARROW STORAGE AND INFUSION IN THE TREATMENT OF MYEOLOSUPPRESSION. N. B. Kurnick (Univ. of California, Los Angeles). Transfusion, 2: 178-87(May-June 1962).

Collection, storage, and subsequent infusion of bone marrow are described, and successful results of infusion of marrow cells in heavily irradiated (2,400 r total dose) patients are reported. In each case, the patient's bone marrow was severely hypoplastic at the time of infusion. No patient suffered ill effects directly attributable to the bone marrow infusion, but excessively rapid intravenous infusion caused headache and substernal oppression. Patients who received autologous or isologous marrow showed recovery of the peripheral leukocyte count in 10 to 28 days with the exception of an infusion given 10 days after 40 mc P^{32}, in which 50 days were required. The time course is similar to that noted in lethally irradiated dogs and monkeys who have been given autologous bone marrow. In contrast, spontaneous recovery of controls required 10 to 145 days with a median of 42 days. Storage is accomplished by slow freezing in a glycerol-tissue culture medium. Slow thawing of marrow and dilution with one-half volume concentrated glucose solution is used for reinfusion. (H.H.D.)

32877 THE INFLUENCE OF HYPOTHERMIA ON THE DEVELOPMENT OF RADIATION SICKNESS IN ANIMALS. M. N. Khanin (Tashkent State Inst. of Medicine, USSR). Trudy Tashkent. Konf. po Mirnomu Ispol'zovan. At. Energ., Akad. Nauk Uzbek. S.S.R., 3: 78-82(1961).

Attempts were made to establish whether hypothermia exerted a therapeutic or prophylactic effect upon radiation sickness. Twelve rabbits were first brought into a state of hypothermia by means of ganglion-blocking drugs and physical cooling and then exposed to x rays in a dose of 800 r. They were kept in the state of hypothermia for a further 2-12 hours. In another experiment 8 rabbits were first exposed to the same dose of x rays and immediately after exposure brought into a state of hypothermia lasting 2-12 hours. Sixteen rabbits were exposed to x rays at normal body temperature (control). Among the 16 control rabbits, 4 perished within 12 days, and one after 90 days; among 12 rabbits exposed to radiation in a state of hypothermia, 4 perished within 12 days and one after 35 days. Among 8 rabbits brought into a state of hypothermia after the radiation, 7 perished within 12 days and only one rabbit survived. The results show that exposure to radiation in a state of hypothermia has the same effect as exposure at normal body temperature. If hypothermia is applied after exposure to radiation it tends to aggravate the course of radiation sickness. This is explained by the assumption that hypothermia exerts no direct effect upon the vegetative vascular reflex response to humoral stimuli: after exposure to radiation the white cell count showed the same changes in the control animals as in the animals kept in a state of hypothermia, changes which are mainly caused by redistribution of the leukocytes in the circulation due to vascular reflexes. The same applies to changes in the serum albumen fraction caused by permeability changes in the vascular wall. It thus appears that the parts of the central nervous system which are inhibited by hypothermia and play an important role in a state of oxygen deficiency or after exposure to painful stimuli, have little or no influence upon the response to irradiation which causes neither pain nor a state of oxygen deficiency. The aggravating effect of hypothermia applied after radiation can be explained by additional exhaustion of the available adaptive mechanisms. (OTS)

CHEMISTRY

General and Miscellaneous

32878 (DP-782) PROCESSING OF POWER REACTOR FUELS, NINETEENTH QUARTERLY PROGRESS REPORT, APRIL 1 TO JULY 1, 1962. J. Harding Owen, comp. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Aug. 1962. Contract AT(07-2)-1. 14p.

A facility to receive and store spent fuels from power and test reactors is under construction at the Savannah River Plant. The facility consists of a system of water-filled basins. It is designed to handle a variety of fuels and casks and to cope with unavoidable releases of radioactive contaminants in the basins without impairing the ability to receive subsequent shipments. Tests in the Semiworks electrolytic dissolver indicate the desirability of insulating the basket from the solution to prevent the basket from carrying current by liquid contact. The concentration of uranium in solutions of irradiated fuel was determined with a precision of 0.28% at the 95% confidence limit by controlled potential coulometry; this laboratory precision is a factor of ten better than the precision of the method generally used. A complete list of the previous reports in this series is appended. (auth)

32879 (IA-749) THE PRODUCTION AND USE OF FLUORINE-18 LABELLED ORGANIC COMPOUNDS. M. Anbar (Israel. Atomic Energy Commission, Tel Aviv and Weizmann Inst. of Science, Rehovoth, Israel) and P. Neta (Israel. Atomic Energy Commission, Tel Aviv). June 1962. 10p.

The production of fluorine-18 labeled organic compounds prepared from F^{18} fluoride ions by synthetic methods and that of compounds labeled by F^{18} produced in situ by the $O^{16}(H^3,n)$ and $F^{19}(n,2n)$ nuclear processes are compared. The advantages of each method are evaluated and the potential application of labeled organic fluoroderivatives in biological studies is discussed. (auth)

32880 (MCW-1475) PROCESS DEVELOPMENT QUARTERLY PROGRESS REPORT, APRIL–JUNE 1962. (Mallinckrodt Chemical Works. Uranium Div., Weldon Spring, Mo.). Aug. 1, 1962. Contract W-14-108-eng-8. 47p.

A spectrochemical system was developed that permits the direct determination of 28 elements in uranium materials by a carrier-distillation technique employing a silver chloride carrier containing 16.4 mole percent strontium fluoride. Precision of analytical results equals that of chemical methods for the determination of iron and silicon at levels found in dingot uranium. Plant tests demonstrated the capability of the refinery to handle phosphate levels as high as 5% on a uranium basis under normal operating conditions. A rapid x-ray spectrographic method for the determination of soluble uranium in raffinate slurry gives results that are in agreement with those of the longer x-ray method and a precision that is comparable. In determination of magnesium oxide in magnesium metal a Grignard reaction is used to dissolve the magnesium metal, the residue containing the magnesium oxide is separated by filtration and dissolved in hydrochloric acid, and the magnesium from the magnesium oxide is titrated with EDTA. The uranium-rich corner of the ternary system of uranium–iron–silicon was investigated at alpha phase temperatures. Only α–U, U_6Fe, and U_3Si were found. (auth)

32881 (MLM-1126) MOUND LABORATORY MONTHLY PROGRESS REPORT FOR NOVEMBER 1961. J. F. Eichelberger (Mound Lab., Miamisburg, Ohio). Nov. 30, 1961. Contract AT(33-1)-Gen-53. 27p.

In plastics research, various ingredients were added to standard clear diallyl phthalate formulations in an effort to improve heat distortion temperature and impact strength in the cured resins. Data are included on milling and physical properties of these resins. Phase A of the adhesive catalog project was continued during the period. Experimental adhesive formulations were prepared with oxiron 2001 resin using anhydride and anhydride-glycol curing systems. Data on these formulations and preliminary evaluations are given. Research on ranger x ray sensor was continued in the areas of film casting techniques, vapor deposition of Be on microfilms, and thickness measurements of uncoated films. Activities in a program to develop processes for separating and purifying radioelements are reported along with efforts devoted to supply source evaluation. Progress toward determination of Ra^{223} half-life is reported. Research on Xe isotope separation and purification is reported along with work on separation of He^3 and He^4 at 1.5°K. Research devoted to determining the fundamental properties of Pu-bearing materials is reported. Data on Pu-Fe alloy density are included along with phase equilibria on Pu-Ce alloy. Calibration of a calorimeter at 100 to 600°C by determining the specific heat of Ni is described. Other work is reported on high-temperature Pu oxide systems and glasses. (J.R.D.)

32882 (ORNL-3314) CHEMICAL TECHNOLOGY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JUNE 30, 1962. (Oak Ridge National Lab., Tenn.). Sept. 21, 1962. Contract W-7405-eng-26. 250p.

A total of 25 sections is incorporated in the report. Separate abstracts were prepared for 22 of the sections. Those sections for which no abstracts were prepared are concerned with Th fuel cycle development, assistance programs, and publications. (J.R.D.)

32883 (ORNL-3314(p.1-39)) POWER REACTOR FUEL PROCESSING. (Oak Ridge National Lab., Tenn.).

Cold laboratory and engineering development of four processes for U- and/or Th-bearing graphite-base fuels is in progress. These include mechanical grinding and leaching with 13 to 15 M HNO_3, combustion-ash dissolution, 90%-HNO_3 disintegration-leaching, and chloride volatilization. Studies were made with both coated- and uncoated-particle fuels, but the only aqueous-based process that is applicable to all graphite-base fuels appears to be the grind-leach. Mechanical grinding followed by leaching with HNO_3 or fluoride-catalyzed HNO_3 generally resulted in recovery of >99% of the U and Th. Coated-particle fuels had to be ground fine enough (−200 mesh) to ensure rupture of the pyrolytic graphite or Al_2O_3 particle coatings. Combustion followed by dissolution of the ash in an acid reagent resulted in nearly quantitative recovery of the U and Th except from fuels that contain Al_2O_3-coated fuel particles, where the inertness of the sintered alumina precludes its dissolution in an aqueous reagent. The ignition temperature of graphite was lowered from about 700 to 300–400°C by presoaking the fuel in lead acetate, $KMnO_4$, or copper nitrate solutions. Simultaneous disintegration and leaching with 90% HNO_3 recovered >99% of the U and Th from fuels that did not contain coated par-

ticles. Both pyrolytic C and Al_2O_3 coatings were impervious to boiling 90% HNO_3, but boiling 90% HNO_3, slowly oxidized graphite. Most of the C that was oxidized was converted to carbon oxides, but about 10% was converted to water-soluble organic acids, 60 to 80% of which was mellitic acid. UC reacted at 25 to 100°C with water, 6 N HCl, or 20 N NaOH to yield principally methane, some H_2, and small quantities of saturated C_2- to C_8-hydrocarbons. The major products of the reaction of UC with 4 or 16 M HNO_3 were carbon oxides and water-soluble polycarboxylic acids, including mellitic and oxalic. Water hydrolysis of ThC, as of UC, yielded principally methane. Hydrolysis studies with mixtures of the higher uranium carbides (U_2C_3 and UC_2), indicated that saturated C_2- to C_3-hydrocarbons were a primary product of the sesquicarbide reaction, while the dicarbide yielded mostly nonvolatile hydrocarbons and some free H_2. The hydrolysis studies indicated that the net result of heat-treating $UC_{1.5}$ at 1600°C was disproportionation of UC to U metal plus the sesquicarbide, although stoichiometric UC was stable under the same heat-treatment conditions. U can be recovered from GCRE-type reactor fuels, which are 70% UO_2–30% BeO pellets clad in Hastelloy-X, either by chopping and dissolving the pellets in 8 M HNO_3–2 M H_2SO_4 or 8 M HNO_3–0.5 M HF, or by dissolving the cladding in 2 to 4 M HNO_3 containing 3 to 5 M HCl and leaching the UO_2 from the pellets with the resulting decladding solution. In simulated chop-leach experiments, Gas-Cooled Reactor Experiment fuel pellets dissolved completely in about 8 hr in boiling 8 M HNO_3–0.5 M HF; the Hastelloy-X cladding was simultaneously attacked at a rate of 0.3 mg min^{-1} cm^{-2}. Dissolution of the 30-mil cladding in 2 to 3 M HNO_3 containing 3 to 4 M HCl required about 3 hr; leaching of the pellets with the resulting solution, which contained about 40 g of Hastelloy per liter, for an additional 6 to 7 hr recovered 99.6 to 99.8% of the U. Fuels containing >90% BeO are best dissolved in boiling H_2SO_4 or HF–NH_4F solutions. In HF solutions, the initial dissolution rate increased from 0 to 1.5 mg min^{-1} cm^{-2} as the HF concentration increased from 0 to 20 M. The Neuflex head-end treatment, a nitrate-free process for dissolving U–Zr–Sn alloy fuels containing up to 10% U, was developed in cold, small-engineering-scale tests. The dissolvent is NH_4F–H_2O_2, and the product is UO_2F_2 solution, which is not amenable to TBP solvent extraction but which can be satisfactorily solvent-extracted to recover U by the Dapex process, which uses D2HPA and DAAP. Ammonium carbonate stripping yields a uranyl tricarbonate product. Dissolution rates were 2–20 mg min^{-1} cm^{-2} at terminal free-fluoride-to-uranium ratios of 50 to 100. The dissolution off-gas consists of 2 moles of H_2, 4 moles of NH_3, and traces of O_2 per mole of Zr dissolved. The dissolver solution is diluted with water prior to solvent extraction. In laboratory-scale batch cascade extractions U recovery was good and separation from Zr was by a factor of 10^4. The Zirflex decladding process at full-activity level was demonstrated in 22 laboratory-scale hot-cell tests with PWR blanket, Zircaloy-clad UO_2, fuel samples irradiated from 182 to 17,700 Mwd/ton. The cladding dissolved in 6 M NH_4F–1 M NH_4NO_3 in 2.5 hr and the pellets in 4 M HNO_3–0.1 M $Al(NO_3)_3$ in 5 hr. Little fracturing of high-density (96% of theoretical) pellets was noted. U and Pu average losses to the cladding solution were 0.01 and 0.09%, respectively. Little difference in losses and rates was noted between cold and hot tests. In laboratory studies on development of a process for Zr-base fuels compatible with Ti equipment, an instantaneous Zr dissolution rate of 10 mg min^{-1} cm^{-2} and a Ti corrosion rate of <0.1 mil/month in refluxing 3 M HNO_3–1.2 M HF–0.4 M HBF_4–0.6 M Cr(III)–0.4 M Cr(VI)–0.46 M Zr were obtained. Two methods for removing chloride from nitrate solutions were evaluated. The addition of 150% of the stoichiometric amount of H_2O_2 to Zr–11 M chloride solutions decreased the chloride content to 0.07 M. At chloride concentrations below 3 M, H_2O_2 was <10% efficient, and complete removal of chloride was not possible. Development effort on chloride stripping from Darex solutions with NO_2 sparging was discontinued when chloride concentrations <0.01 M (350 ppm) were not achieved routinely with reasonable excesses of NO_2 even in a 20-ft-high packed column. Initial tests with NO met with some success, 0.01 to 0.02 M chloride being achieved with 450% of theoretical NO required. Addition of HBF_4 or molybdic acid to the Darex dissolvent did not solubilize silica in fuels containing >0.5% Si. However, treatment of a solution of APPR fuel, containing 2% Si, produced a silica precipitate that did not plug lines and equipment as did that formed with untreated APPR fuel solutions. With HBF_4, 17% of the fluoride was volatilized; addition of 0.01 M Zr decreased the fluoride volatility to 2%. A preliminary phase study of the constant-boiling system H_2O–HCl–Zr showed a series of hydrated compounds with melting points of 68–110°C and boiling points of 100–112°C between 0.5 and 4.2 M Zr. Removal of $ZrCl_4$ from off-gas streams by hydrolysis during passage over boiling, near azeotropic, HCl–Zr solutions appeared feasible. Haynes 25 and 21 were superior to Ti in resisting corrosion in boiling Darex dissolvent containing 0.1 M HBF_4. Maximum rates were 0.36, 2.4, and 60 mils/month, respectively. Unwelded Corronel 230, a new alloy, developed for HF-oxidant service, was corroded at maximum rates of 2.83, 59.9, and 0.71 mils/month in 10 M HNO_3–0.5 M HF at 60°C and at boiling without and with the addition of 0.75 M Al^{3+}, respectively. Ti was corroded at a rate of 0.07 mil/month in the latter solution. Rates of Corronel 230 in 1 M HNO_3–3 M HF, at 60°C and at boiling were 4.97 and >2700 mils/month, respectively. In boiling 1 M HF with and without the addition of 0.06 M H_2O_2, rates were 12.7 and 43.7 mils/month, respectively. In refluxing 20 to 23 M HNO_3, maximum corrosion rates of Ti and Corronel 230 were 0.07 and 7.27 mils/month. In boiling 20 M HNO_3–50 g/liter U solution containing free graphite, the corrosion rates for Ti, mild steel, and type 1100 Al were 0.03, 688, and 127 mils/month, respectively. In boiling 23 M HNO_3–1 M HF, types 6061 aluminum and 309SNb stainless steel were corroded at rates of 0.01 and 0.6 mil/month, respectively. In 90% HNO_3–10% H_2SO_4, Nichrome V, Carpenter 20SNb, types 304 and 347 stainless steel, INOR-8, and CD4MCu were corroded at maximum rates of 0.20, 2.6, 4.1, 3.1, 0.17, 0.52, and 1.74 mils/month, respectively. In flowing modified Zirflex dissolver solution at the boiling point, welded type 347 stainless steel and rolled, unwelded Haynes 21 were corroded at maximum rates of 6.45 and 0.68 mils/month, respectively. In modified Zirflex solvent-extraction feed solutions at 50°C, LCNA, Carpenter 20SNb, and types 304L and 347 stainless steel were corroded at maximum rates of 0.04 to 0.25, 0.08 to 0.46, 0.38 to 0.49, and 0.10 to 0.19 mil/month, respectively. In spent Zirflex core dissolvent (35°C) containing 0 to 0.09 M uncomplexed fluoride, Ti and Hastelloy-F were corroded at maximum rates varying from 0 to 8.5 and from 0.08 to 0.69 mils/month, respectively. Type 347 stainless steel was corroded at a maximum rate of 0.02 mil/month in 1 M HNO_3–2 M acetic acid–45 g of $UO_2(NO_3)_2 \cdot 6\ H_2O$/liter under heat transfer conditions. In chloride volatilization processing tests, INOR-8, Nichrome V, and Haynes 25 were corroded at average rates of 0.7, 2, and 6 and 100, 800, and 800

mils/month at 500 and 700°C, respectively, in dry Cl_2 gas. Rates in CCl_4-N_2 were about the same as those in Cl_2. Rates in O_2 at 725°C and in anhydrous HCl at 600°C were 0.02, 0.01, 0.01, 0 and 5.30, 5.63, 16.4, and 1.2 mils/month for Haynes 25, Nichrome V, INOR-8, and Pyroceram 9608, respectively. The UO_2 dissolver solutions prepared in the Zirflex hot-cell tests were evaluated through one cycle of 30% TBP solvent extraction. U and Pu recoveries were nearly quantitative, and gamma decontamination factors were 2×10^4 and 7×10^3, respectively. In solvent recycle tests with these feeds, solvent degradation was much less when n-dodecane was the diluent than when Amsco 125-82 was used. The acid Thorex process was satisfactorily modified to provide for simultaneous recovery of U and Th from Consolidated Edison Darex cladding and Thorex core solutions. Only 1% of the fission product activity was removed from irradiated ThO_2 slurry by 6 hr of leaching with 1 to 5 M HNO_3. When a solution containing 116 g of thorium per liter, 6.2 M HNO_3, and 3.76×10^5 counts min^{-1} ml^{-1} of Pa^{233} was passed through a column of unfired Vycor glass, about 97% of the Pa and < 0.01% of the Th was absorbed. The Pa was eluted with oxalic acid. In solvent extraction with 30% TBP, about 98% of the tracer concentrations of Pa and 99.9% of the Th and U were extracted. Decontamination factors were 70 and 10^5, respectively, from Ru and rare-earth elements, the principal neutron poisons. Laboratory experiments with synthetic solutions indicated that Th may be removed from U^{233} product solutions by either ion exchange or solvent extraction processes. Modifications in the U–Al and U–Zr alloy fuel solvent extraction flowsheets were developed which provide increased plant capacity and decreased waste volumes. No difficulties were encountered in solvent extraction of solutions made by the 90% HNO_3 leaching of Pebble Bed Reactor graphite-base fuel containing tracer amounts of fission products, but about half the Zr and Nb were adsorbed on the graphite during leaching, and 1% of the Ru volatilized during the evaporation of the excess acid. In studies on the distribution of Nb^{95} between 30% TBP in n-dodecane and aqueous nitric acid, the amount of Nb in the extractable form decreased from ~30% in 4 M HNO_3 to ≤5% in 0.1 N acid-deficient solution, and the distribution coefficient of the extractable portion decreased from 0.05 to ~0.008. The presence of chemical degradation products of TBP and Amsco 125-82 increased the amount of extractable Nb, the distribution coefficient of the extractable form, and the amount of Nb retained by the organic phase. Pu was strongly adsorbed from 0.5 M HNO_3 on zirconia-silica-phosphate. Flow capacities and stage efficiencies were determined for a variety of flowsheet conditions. Tests of a dilute Purex flowsheet, designed to eliminate intercycle evaporation, in the 2-in.-dia. pulsed columns showed considerably lower flow and U production capacity than expected. Electrostatic treatment of solvent extraction streams improved de-entrainment 20- to 50-fold. The mechanical dejacketing of the Core 1 fuel assemblies from the Sodium Reactor Experiment, which were irradiated to 675 Mwd/ton and decayed for 2 years, was successfully completed, and the declad fuel was shipped to the Savannah River Plant. The irradiated fuel cladding was highly hardened and much more difficult to handle than the ductile unirradiated assemblies. The cladding on about 7% of the fuel had to be chipped off with remotely operated hand tools. The slugs were satisfactorily steam-cleaned and recanned, and 18 liters of NaK were destroyed with steam. Two NaK explosions occurred, but damage to equipment was minor and no injuries or spread of activity occurred. Installation of the cold shear-leach facility in building 4505 was completed and engineering demonstration of this process on unirradiated prototype power reactor fuels started. The shear and leacher were completely tested hydraulically and mechanically. The shear blade showed little wear after 3000 cuts on stainless-steel-clad porcelain mock fuel. Particle-size determinations indicated that small-size fines were predominantly porcelain and large pieces mostly metal. Less than 0.1% of all particles were < 0.25 μ. It was determined that fuel could not be sheared to lengths < 0.5 in. without closing the tubing. An assembly can be sheared down to 1.5 in. terminal length. Sulfuric acid dissolution of cladding scrap from Yankee fuel samples irradiated to 8130 Mwd/ton showed only 0.02% of the U and Pu in the clad after leaching and washing. Designs of pilot plants for the Darex and Shear-Leach processes were begun as a joint ORNL-ICPP (Idaho Chemical Processing Plant) effort. The pilot plants were to be installed at the ICPP, but both projects were cancelled by the AEC in April 1962. Full criteria were prepared for the Darex pilot plant and transmitted to the ICPP, along with the half-completed Darex design formerly planned for cell 3, building 3019. ORNL and the ICPP then jointly prepared engineering flowsheets, and design of process equipment was started. Criteria had been started for the Shear-Leach installation and location studies begun by an architect-engineer when it was cancelled. Assistance was provided the ICPP on their plans for a Pu solvent extraction and isolation facility. Criteria were prepared by ORNL for a trilaurylamine (TLA) extraction system that would permit the ICPP to compare this with existing anion exchange methods. (auth)

32884 (ORNL-3314(p.39-57)) FLUORIDE VOLATILITY PROCESSING. (Oak Ridge National Lab., Tenn.).

Modifications to the Fluoride Volatility Pilot Plant required to scrub the dissolver off-gas with liquid HF were completed, and the system performed excellently in all tests. The last five of a series of flowsheet demonstration runs (TU-8 to TU-12) with nonirradiated fully enriched Zr–U alloy fuel elements were successfully completed, and 5.2- to 6.5-yr-decayed U–Zr alloy fuel was successfully processed in six runs. Automatic data logging and digital computer techniques were routinely used for processing data. Stainless steel dissolution rates and component solubilities were determined in 29-36-35 mole % $LiF-NaF-BeF_2$, as were dissolution rates in 40-49-11 and 36-44-20 mole % $LiF-NaF-BeF_2$. Simulated EBR meltdown fuel containing trapped NaK was dissolved in molten $NaF-LiF-ZrF_4$ with HF with no difficulty. U was successfully recovered from unirradiated Zircaloy-clad UO_2 pins which had decayed only 15 to 30 days. Over-all process decontamination factors varied from the order of 10^2 for Mo γ activity to 10^8 for Sr β activity. Radioactivity from I^{131} γ, Te β, Mo β, Nb γ, and Ru γ tended to disappear in the dissolution step. Scouting tests made with irradiated $BeO-UO_2$ and ThO_2-UO_2 fuels indicated the feasibility of using the fused salt volatility process but also showed that more work is needed in developing the chemistry and the optimum salt system for each case. Parallel slabs of zirconium oxide were hydrofluorinated in 26-43-31 mole % $NaF-LiF-ZrF_4$ for rate comparisons with previous Zircaloy-2 dissolutions. Comparison of the resistance of INOR-8 vs Alloy 79-4 in $NaF-LiF$ with ZrF_4 and BeF_2 indicated that potential usefulness of the latter as a hydrofluorination construction material. However, corrosion was high at the salt-vapor interface when dissolving Zircaloy-2 in 50.5-37.0-12.5 mole % $NaF-LiF-BeF_2$ with HF at 650°C. Alloy 79-4 was more resistant than either L-nickel or INOR-8 in a $NaF-LiF-ZrF_4$ melt with and

without BeF_2 under fluorination conditions. Generally, the BeF_2-containing melt was the more corrosive. INOR-8 corrosion data accumulated during prototype hydrofluorination rate studies were correlated with the kinematic viscosity of molten salt. Results were favorable when UF_6 was volatilized from 29-36-35 mole % $LiF-NaF-BeF_2$ fused salt (~350°C liquidus); such a low-melting-point salt might be valuable in minimizing fluorinator corrosion. Nickel vessels were corroded rapidly with 40-49-11 mole % $LiF-NaF-BeF_2$ at 600°C. Prototype equipment was revised for study of salt recycle in Zircaloy-2 processing (for cost reduction) and to provide for inclusion of Be compounds in the study. The $NaF-UF_6$ reaction kinetics study resulted in a mathematical model in agreement with experimental observations. (auth)

32885 (ORNL-3314(p.58-95)) WASTE TREATMENT AND DISPOSAL. (Oak Ridge National Lab., Tenn.).

The design of a pilot plant for the demonstration of the pot calcination process for converting high-activity wastes to solids at the Idaho Chemical Processing Plant was carried through the preparation of engineering flowsheets. Engineering-scale studies with simulated Purex, TBP-25, and Darex wastes demonstrated the operability of both continuous and batch evaporators in feeding 8-in.-dia. by 90-in.-high pot calciners at rates of 10 to 25 l/hr. The volume of noncondensable off-gas from the process ranged from 15 to 50 ft^3/hr. Solids, deposited radially in the pots during calcination, contained an average of a few tenths percent nitrate and had bulk densities of about 1.2 g/cc in the case of Purex and Darex and 0.7 g/cc in the case of TBP-25 waste. Volatilization of sulfate from the calciner to the evaporator was limited to <1% by the addition of calcium nitrate solution. Hg was completely volatilized, together with up to 50% of the Ru. Ru volatility can be decreased by adding reducing agents such as NO or phosphite. Design and procurement of mechanical equipment for remotely positioning and connecting the calciner to process equipment in the pilot plant were completed. The equipment was assembled and is being tested. Simulated highly radioactive wastes from the TBP-25, Purex, and Darex processes were incorporated in glassy or microcrystalline solids by adding phosphite or hypophosphite and other fluxing agents and calcining. Volume reductions varied from about 7 to 9.3 for TBP-25 and from about 2.9 to 6.6 for Darex. Corresponding densities varied from about 2.35 to 2.84 g/cc and from about 2.2 to 3.8 g/cc, respectively, and softening points from 850 to 1000°C and from 850 to 900°C. The addition of phosphite or hypophosphite to 1.5 to 2.5 M not only provided a fluxing agent but also decreased the Ru volatility to <0.1% in batch and in small semicontinuous experiments. Semiengineering-scale fixation of TBP-25 waste in a true glass incorporating 26 wt % simulated waste oxides was accompanied by volatilization of 12.5% of the Ru, with physical entrainment of 0.02% or less. The thermal conductivity of this glass varied from 1.05 to 1.60 Btu hr^{-1} ft^{-1} $(°F)^{-1}$ between 300 and 1050°F (softening point, ~1100°F). Vapor-liquid equilibrium data and solution densities were determined for TBP-25, Darex, and Purex wastes for concentrations from 0.5 to 1.5 to 2 times those of the expected waste solutions and at acid concentrations as high as 7 M when such solutions were stable. In nitrate solutions, the logarithm of the Ru distillation factor was a linear function of the logarithm of the HNO_3 molarity in the distillate. Dissolved salts increased the relative volatility. Addition of 0.1 M H_3PO_3 decreased the relative volatility by factors varying from 38.8 for simulated Darex waste to 447 for 12 M HNO_3. Addition of 1.5 to 2.5 M phosphite or hypophosphite to simulated TBP-25 waste solution lowered the Ru volatility to 0.1% or less during calcination up to 900°C. Stainless steel appears to be a satisfactory construction material for both the calciner pot and the waste storage tanks. Type 304L stainless steel was corroded with average penetrations of 0.14, 1.11, and 4.5 mils when exposed to TBP-25, TBP-25 + glass additives, and Purex + glass additives, respectively, for 19 to 24 hr, including the evaporation-fixation cycle and final heating to 900°C. Intergranular corrosion occurred in the Purex environment. Corrosion was maximum in all environments during the relatively short time at high temperature when the last water and acid were being expelled. Little further internal corrosion is expected during storage. Type 304L stainless steel can be used for the calcination pot if sulfate volatility from Purex waste is properly controlled and if maximum fixation temperatures are kept below 900°C. Atmospheric corrosion in dry air at 900°C was <16.8 mils/yr. Stainless steels exposed in simulated Darex waste solution for 6082 hr at 80°C showed over-all rates of about 0.9 mil/month and grain-boundary attack but no intergranular attack. The addition of organic inhibitors and lowering the temperatures 40 to 50°C decreased the rate to a few hundredths of a mil per month. These stainless steel tanks are probably satisfactory for the storage of acid nitrate wastes. A scavenging-ion exchange process for removing trace amounts of fission products from process waste water was demonstrated with ORNL waste in a 600-gal/hr pilot plant. When the feed is adjusted to a pH of 11.6 with caustic in a flash mixer, a precipitate is formed which scavenges the colloidal solids and part of the radioactivity. After flocculation, the solids are separated with a sludge-blanket clarifier and polishing filter and are further concentrated for disposal by a sludge filter. The clarified liquid is passed through a bed of Duolite CS-100 phenolic resin for sorption of most of the remaining activity. After passage of 2000 bed volumes through the ion exchange column, the plant effluent contained <3% of the maximum permissible concentration of Sr^{90} and Cs^{137} in drinking water for continuous occupational exposure. The Sr^{90} decontamination factors ranged from 2,047 to 12,160, representing >99.9% removal; Cs^{137} decontamination factors ranged from 77 to 3444 for the same operating time. Other tests in the pilot plant showed a 50% breakthrough point for Cs^{137} at 2800 resin-column volumes, demonstrated the feasibility of the split-elution method with 0.5 M HNO_3, and showed no effect from the variation of the length-to-diameter ratio of the resin bed. Laboratory studies with tap water showed that calcium hardness remaining in the clarifier effluent can be decreased from 70 ppm to <10 ppm by the addition of 25 ppm of lime at 25°C but that it was ineffective with ORNL waste containing complexing agents, that vermiculite is not suitable for use with the high-caustic head-end treatment of ORNL waste and, that the treatment of 20,000 bed volumes in a complete demineralization flowsheet should be possible before regeneration of the resin is required. A conceptual design and cost estimate for a 750,000-gal/day plant for treating the total ORNL process waste stream indicated a capital cost of $511,000 and an estimated operating cost of 54 cents per 1000 gal. A study undertaken to evaluate the economics and hazards associated with alternative methods of waste management in a nuclear power industry showed that costs for converting acid and reacidified Purex and Thorex wastes to solids by pot calcination and for producing glass from acid Thorex wastes ranged from 0.87×10^{-2} mill/kwh_e for processing acid Purex and Thorex wastes in 24-in.-dia. vessels to 5.0×10^{-2} mill/

kwh_e for processing reacidified Purex and Thorex wastes in 6-in.-dia. vessels. A preliminary conceptual design and cost estimate for a solids disposal facility in salt indicated costs of 6×10^{-3} to 30×10^{-3} mill/kwh_e. Of the total costs, 60 to 85% was attributable to salt removal, indicating that the best possible estimates of this item will be required for the more detailed final study. Heat-transfer calculations of shipping containers for pot-calcined wastes of various ages showed that as many as thirty-six 6-in.-dia. pots of calcined acid Purex waste can be shipped in a single-finned carrier after 2.4 years' decay without mechanical cooling en route. Four 24-in.-dia. pots of acid Purex waste can be shipped, per carrier, after 11 yr of decay. (auth)

32886 (ORNL-3314(p.96-115)) SOLVENT EXTRACTION TECHNOLOGY. (Oak Ridge National Lab., Tenn.).

Chemical and physical performance of the chemical flowsheet developed for final-cycle Pu purification by tertiary amine extraction was demonstrated in countercurrent runs with simulated feeds and with Purex plant solutions. Pu distributions confirmed the previous equilibrium measurements, with satisfactory recoveries and concentration factors. Decontamination factors from the simulated solutions with tracer Zr–Nb were near or above analytical limits, but those from Purex solutions were only 100 to 500, much lower than expected and than required for an acceptable Pu product. In cold engineering tests in a 2-in.-dia. pulsed column and in mixer-settlers, flow capacities and stage efficiencies were determined for a variety of flowsheet conditions. Detailed examination of the behavior of lanthanides, Y, and Sc in the amine chloride extraction method for separating transplutoniums from lanthanides showed Y less extractable than any lanthanide under all conditions tested. Sc extraction was higher than that of Y but varied greatly with extractant composition. The order of extractability of the lanthanides varied with extractant and aqueous composition, with maximum extraction near the middle of the series from 11 N LiCl–0.01 N HCl but, with most extractants tested, at the high-weight end from 8 N LiCl–2 N $AlCl_3$. Continued studies on amine extraction of fission-product metal nitrates showed marked variation in the extraction of nitrosyl Ru with age and contact time. Extraction of nitrato complexes (tetra- and penta- most extractable) passed through maxima at ~3 M HNO_3 in the absence of nitrate salts but continued to rise with decreasing acidity in the presence of sodium nitrate (~6 M NO_3^-) down to <0.5 M HNO_3; E_a^0(Ru) was up to ~0.6 with ~0.25 M amine. Extractions of nitro complexes were in a similar range but rose with decreasing acidity both with and without nitrate salt present. Extraction of Fe(III) from chloride solutions by several amines varied in the order quaternary > tertiary > secondary ≫ primary, and (with secondary amine) aromatic diluent > (aliphatic + alcohol) diluent. It increased throughout with increasing chloride concentration (acid or salt) up to 10 M, except for slight decreases at >8 M HCl with the quaternary and tertiary. A useful balance between acid extraction power by amines and amenability to water stripping of the extracted acid was obtained by proper choice of the degree of steric hindrance from alkyl branching close to the nitrogen. N-Benzyldi(2-ethylhexyl)amine, in particular, was found capable of extracting >90% of the sulfuric acid from Sulfex decladding process waste and releasing it to a stripping solution which can reach a concentration of ~1 M H_2SO_4. Continued tests of diluent nitration showed it to be more severe in the presence of TBP. The degradation as measured by tracer Zr–Nb extraction, by nitroparaffin determination, or by total organic nitrogen determination, was essentially the same from heating and from irradiation, for example, 10 hr reflux with 2 M HNO_3 was equivalent to ~100 whr/liter of Co^{60} gamma irradiation. Amsco 125-82 was less susceptible to nitration after being scrubbed with concentrated H_2SO_4. Of many scrubbing agents tested, ethanolamine proved most effective in removing Zr–Nb-extracting impurities from degraded solvent. However, the economic value appears marginal because of appreciable loss of both TBP and ethanolamine and the relatively high price of the latter. Continued search for diluents more stable to nitration showed large variations in stability with structure of alkylbenzenes. Di- and cycloalkylbenzenes were less stable than simple monoalkylbenzenes, with indication that triethylbenzene was even more stable and monoalkylbenzenes more stable when iso-branched than when either more branched or normal. These comparisons apply only to side-chain nitration; nitration of the benzene ring does not produce Zr–Nb extractants, although it must still be considered in respect to physical properties and safety. Significant suppression of Zr–Nb and Ru extraction was demonstrated on treating aqueous feeds with certain oximinoketones, a class of compounds previously proposed as intermediary in similar suppressions by treatment with acetone plus nitrite. Further study of oximinoketones showed that a part of their effect was due to oxalic acid, present as either a synthesis by-product or a decomposition product of the oximinoketone. Direct batch tests showed oxalic acid more effective than oximinoketones in suppressing Zr–Nb and Ru extraction but indicated some limitations through impaired extractions or precipitation of Pu, U, and Th. In spite of such limitations, the use of oxalic acid feed treatment, in processing actual irradiated-fuel solutions, improved the decontamination of U from gross beta and gamma activity by a factor of 20 to 30, without any impairment of over-all U or Pu recovery. In continuing examination of new potential extractants supplied by manufacturers, a commercial supply of di-sec-butyl phenylphosphonate (DSBPP) compared well with the previous research preparation, and a number of new or modified amines compared well with previously available amines in assay and performance. Secondary amine contamination was removed from tertiary amines by column cation exchange in an isopropanol medium. Preliminary evaluations of the gel-liquid extraction technique, which uses the tertiary amine Alamine-336 absorbed in polystyrene-divinylbenzene beads, showed high separations but slow equilibration in the transplutonium-lanthanide-LiCl system. While this technique does not appear competitive with conventional solvent extraction for separations in that system, the results indicate possible advantages in systems offering only small separation factors and with extractants limited by poor miscibility with common diluents. Continued studies of alkaline earth extraction by di(2-ethylhexyl)phosphate ($[HX]_2$ + NaX) in benzene showed $E_a^0(Sr) \propto [H^+]^{-1.7}$ (average) at pH < 4, passing through maxima near pH 4.5–5.5, and independent of pH at >7. The maxima occurred at lower pH with higher reagent concentration (0.015 to 0.5 M X^-), in each case close to the pH where the mole ratio $NaX/\Sigma X \approx 0.25$. The extraction maxima disappeared when all sodium nitrate was replaced with strontium nitrate, $E_a^0(Sr) \propto [X^-]$ at all levels of $NaX/\Sigma X$, suggesting extraction into micelles of the reagent. The relative affinities of the alkali ions for di(2-ethylhexyl)-phosphate in extraction from nitrate-hydroxide solutions was Cs ≈ Rb < K < Na ≪ Li ≪ H. Results were similar with 0.5, 0.1, and 0.05 M X^-. The relative affinity of lith-

ium in particular increased considerably with a decrease of aqueous pH and organic MX/ΣX. Water extraction and the concomitant volume increase on conversion of $[HX]_2$ to NaX was measured in detail in the system D2EHPA-benzene-4 M $NaNO_3$–NaOH. The organic volume increase was $\propto M_{NaX}$ at constant NaX/ΣX. Extracted water expressed as H_2O/NaX varied as a linear function of NaX/ΣX. The vapor pressures of a series of water-saturated solutions of $[HX]_2$–NaX mixtures in benzene indicated average aggregation numbers of 3 to 8 at mole ratios NaX/ΣX = 0.25 to 0.75 at ΣX = 0.4 M. Transfer-rate measurements of tagged sulfate from amine solution of aqueous sulfate solution, with and without simultaneous extraction of uranyl sulfate from the aqueous solution, failed to show any evidence of actual $UO_2(SO_4)_3^{4-}$–SO_4^{2-} exchange, thus strengthening previous indications that neutral UO_2SO_4 is the species actually transferred under the conditions examined. (auth)

32887 (ORNL-3314(p.116-25)) FISSION PRODUCT RECOVERY. (Oak Ridge National Lab., Tenn.).

The solvent extraction process for recovering and separating Sr and mixed rare earths with di(2-ethylhexyl)phosphoric acid was demonstrated successfully in hot cell tests with actual Purex concentrated waste in continuous miniature mixer-settler equipment. This process was further developed and modified at Hanford to recover megacurie quantities of Sr^{90}. The same solvent can be used to recover Zr and Nb. New solvent extraction processes, using certain phenols, were developed for selective recovery of Cs from Purex wastes and tank farm supernatants, and amine extraction processes were developed for pretreating the wastes to remove HNO_3, Fe, sulfate, Zr–Nb, and Ru and produce a better feed liquor for recovery of other fission products. The same process may be useful for isolating Zr–Nb and rare earths. In combination with the TBP process for Pm separation developed several years ago, these new developments offer a versatile, integrated solvent extraction flowsheet for recovery and purification of all fission products of principal importance from waste liquor. A procedure is proposed for recovering Sr from Purex waste by a head-end double precipitation step prior to ion exchange. Sulfate ion is removed from the waste with 55 to 60% HNO_3, and Sr is recovered from the almost pure nitrate filtrate, 85% HNO_3. Radiochemical and wet analyses of the product solution of a test run indicated that 75 to 80% of the Sr was recovered together with 1% each of Fe^{3+}, Al^{3+}, Na^+, and SO_4^{2-}. (auth)

32888 (ORNL-3314(p.126-55)) TRANSURANIUM ELEMENT PROCESSING. (Oak Ridge National Lab., Tenn.).

The HFIR and TRU Facilities are being built to produce gram quantities of the heavier transuranium elements for research uses. As part of this program, chemical separation processes and TRU Facility design are being developed. Laboratory development of methods for isolating the various transuranium elements and process-equipment design and testing were continued. The high-activity-level development facility in building 4507 was designed, and construction in cell 4 was begun. TRU Facility Title I design was completed. About 3% of the Al in HFIR targets will be converted to Si during an 18-month irradiation. The dissolution rate of Al containing 0.1 to 3% Si in 1 to 6 M HCl was inversely proportional to the Si content, and directly proportional to the cube of the acid concentration. The rate doubled for every 8 or 9°C increase in temperature. An alloy containing 3% Si dissolved at a rate of 10 mg min^{-1} cm^{-2} in 6 M HCl at 80°C. In demonstration runs of the Tramex process (tertiary amine extraction process for separating actinides and lanthanides) with 6 extraction, 6 scrub, and 6 stripping stages, total Am losses were ~0.01% and the decontamination factor from rare earths was $>10^4$. The ions Pd^{2+}, Fe^{3+}, Ti^{4+}, Ru^{4+}, TcO_4^-, Zr^{4+}, MoO_4^{2-}, and Ni^{2+} were extracted with the Am but rare earths Ru^{3+}, Y^{3+}, Ba^{2+}, and Sr^{2+} were not. The extracted contaminants except Ti^{4+} and Ni^{2+} will remain in the organic phase when Am^{3+} is stripped with 5 to 10 M HCl. Ru behavior is not completely predictable since it exists as both tri- and tetravalent ions in these solutions. Both actinide and lanthanide distribution coefficients increase rapidly with increasing nitrate ion in the system. However, lanthanide extraction increases more rapidly, and the Am–Eu separation factor decreases from 100 for 0.01 NO_3^- to 1 at ~0.7 M NO_3^-. In countercurrent demonstration runs of the phosphonate extraction process for separating transcurium elements from Am and Cm with 4 extraction, 3 scrub, and 3 stripping stages, total Cf losses were ~0.1%, and the Am decontamination factor from Cf was 10^3. In runs made with Eu as a substitute for Bk, with 8 extraction and 8 scrub stages operating at ~50% efficiency, 99.9% of the Eu was extracted, and the Am decontamination factor was 2×10^3. The separation factor of 30 between Bk and Cm makes this an ideal system for separating the transcurium elements from Am and Cm. However, separation factors for other adjacent actinides range from 1.3 to 3.3. Distribution coefficients are directly proportional to the cube of the phosphonate concentration and inversely proportional to the cube of the acidity over the range 0.5 to 4 M HCl. Extraction decreases to a minimum at 5.5 to 7 M HCl concentration. Distribution coefficients are greater with aliphatic diluents than with aromatic diluents. The following contaminant ions were quantitatively extracted: Zr^{4+}, Ti^{3+}, Fe^{3+}, MoO_4^{2-}, and Pu^{4+}. The contaminants Si^{2+}, Ru^{3+}, and Ni^{2+} remained with the Am and Cm. An anion exchange process for recovery of Am, Cm, and rare earths from Pu process waste was developed and tested on a laboratory scale. With a feed containing 2.34 M $Al(NO_3)_3$, 1.5 g of rare earths per liter, and tracer Am, a product containing 8.5 g of rare earths per liter and 0.05 M Al was obtained. No Am losses were detectable and decontamination from Fe was essentially complete. Am losses increased with increasing resin size, with decreasing resin cross linkage, and with increasing flow rates. Conversion from a nitrate system to a chloride system by tertiary amine extraction of HNO_3 from a mixed HCl–HNO_3 solution was successfully demonstrated. Bk in 8 M HNO_3 can be oxidized to Bk^{4+} with ozone or $KBrO_3$ and then extracted with 30% di(2-ethylhexyl)phosphonic acid in decane or hexane diluent. Toluene, diethylbenzene, and Amsco 125-82 diluent reduced the Bk back to Bk^{3+}. When Am and Cm hydroxides were dissolved in 3 M K_2CO_3 and the solution was oxidized to form Am^{6+}, 80% of the Am, but only 1% of the Cm precipitated. When a column of Dowex 50-12X (200 to 400 mesh) resin loaded with 0.4 μg of Cf^{252} 0.26 nanogram of Es^{253}, and 0.3 picogram Fm^{254} was eluted with 0.4 M ammonium α-hydroxyisobutyrate at pH 4.1, the first column cut contained 0.3% of the Cf, 20% of the Es, and 60% of the fermium. By the time 10% of the californium was eluted, 80% of the einsteinium and 90% of the Fm were also eluted. In a second test, a small amount of gassing disrupted the resin bed and gave poor separations. Scouting tests with chloride solutions containing 20 g of Am^{241} per liter (2 w/liter) indicated no direct effects on corrosion rate from alpha radiation. Secondary effects attributable to H_2O_2 from radiolysis were noted. Equipment was designed and is

being constructed in cells 3 and 4 of building 4507 to test the solvent extraction processes for transuranium element isolation at full activity levels. Calculations indicate that the dissolution rate of Al in HCl can be adequately controlled by temperature and acid concentration. Oracle calculations with laboratory data confirmed that it is practical to separate Am–Cm from the heavier lanthanides, but not Bk from Cf. A mixer settler with improved impeller and interface weirs performed satisfactorily with the amine extraction flowsheet, and a stage height of 18 in. with a capacity of 120 gal hr^{-1} ft^{-2} at 50°C was obtained in a pulsed column with this same flowsheet. A piping disconnect designed for remote operation was satisfactory. Leakage was less than 10^{-6} cc of helium per second after ten makes and breaks and after simulated mechanical damage or misalignment. A pressurized-water fire extinguishing system for glovebox fires was developed and demonstrated. Conceptual design studies to determine the criteria to be followed in TRU equipment design were completed. Included were tentative irradiation and processing schedules and equipment flowsheets. Conceptual layouts of all TRU process equipment were completed, and detailed design of line penetration and disconnect wells was started. The conceptual design and Title I engineering of the TRU Facility was completed and detailed design started. Shielding calculations indicated that 54 in. of magnetite concrete and a 54-in.-thick compound window of oil and lead glass will provide sufficient shielding. The interior walls of the cells are expected to read < 1 r/hr from neutron activation ten days after credible exposure to spontaneous fission neutrons. Tentative maximum permissible environmental concentrations of the actinides were calculated. A hazard analysis based on these values indicates that the TRU facility design meets current containment criteria. (auth)

32889 (ORNL-3314(p.156-9)) PLUTONIUM–ALUMINUM ALLOY FUEL PROCESSING. (Oak Ridge National Lab., Tenn.).

Pu was recovered from 24 highly irradiated Al–Pu alloy rods. Objectives of the program included recovery of Pu rich in the higher isotopes, generation of feed material for future transuranic flowsheet demonstrations, and the demonstration of a flowsheet for recovery of highly burned Pu by anion exchange methods. A total of 675 g of Pu meeting specifications was recovered, with average decontamination factors from fission products of 1×10^6. Over-all losses averaged 1%, the bulk (80%) of which occurred in the first cycle during the scrubbing step. The Permutit SK resin used was severely degraded after receiving a dose of 4×10^8 rad. (auth)

32890 (ORNL-3314(p.159-64)) PRODUCTION OF URANIUM-232. (Oak Ridge National Lab., Tenn.).

A total of 32.9 mg of U^{232} for nuclear cross-section measurements was prepared by neutron irradiation of Pa^{231} and chemical isolation of the U. The principal product solution contained 21.58 mg of U^{232} with an isotopic composition 98.90% U^{232}, 0.0127% U^{233}, 0.0095% U^{235}, and 1.075% U^{238}. The remainder of the U^{232} product contains about 0.03% U^{233} and 0.003% U^{236}. Uranium-235 and U^{238} contamination resulted from ~7 ppm of natural U in the Pa_2O_5 from which the U^{232} was produced and from traces of U in process reagents. Six Al–Pa_2O_5 cermet targets containing a total of 48.1 g Pa^{231} were fabricated. Two irradiations were made. In the first irradiation, one target containing 7.35 g of Pa^{231} was irradiated to 4.7×10^{18} nvt and processed for U recovery after 43-hr decay and again after 91-hr decay. In the second irradiation, five targets containing a total of 40.6 g of Pa^{231} were irradiated to 4.1×10^{18} nvt and processed for U recovery after 43-hr decay and again after 77-hr decay. The irradiated slugs were processed by dissolution in HCl and HCl–HF and anion exchange. The U was further purified by a second anion exchange cycle and a TBP extraction. Another 1 g of U^{232} containing about 1% U^{233} is being prepared by a longer reirradiation of the Pa^{231}. (auth)

32891 (ORNL-3314(p.165)) URANIUM PROCESSING. (Oak Ridge National Lab., Tenn.).

U mill waste streams normally contain Ra^{226} at a concentration too high to permit direct discharge to the environment. The Ra was removed to below specification limits (10×10^{-12} curie/liter) from simulated plant waste solution by adsorption on natural and synthetic zeolites. UO_2 particles (< 10 μ) were enclosed in BeO by drying and igniting a suspension prepared in a syrupy solution of basic beryllium formate or oxalate. The refractory BeO was obtained as a slightly porous glassy mass, or (by a dispersion technique) as small spherical beads, which, however, were more porous and would require subsequent densification. (auth)

32892 (ORNL-3314(p.166-8)) PROTACTINIUM CHEMISTRY. (Oak Ridge National Lab., Tenn.).

Present chemical processing methods are not adequate for large quantities of Pa^{233} in Th fuels. To obtain basic Pa chemical information for future process development the chemistry of Pa in sulfuric acid solutions is being investigated by solvent extraction, solubility, and spectrophotometric methods. The solubility is 0.12 to 0.20 mg/ml in 27 to 33 N sulfuric acid, but increases below 20 N acid to as much as 6 mg/ml. Pa hydrolysis occurs at concentrations below 10 N. Organic amines will extract Pa from sulfuric acid solutions, the order of extraction being tertiary < secondary < primary. The extractability increased approximately linearly with amine concentration, and increased quite rapidly with decreasing sulfuric acid concentration. A single absorption peak occurs at 2250 Å in sulfuric acid concentrations above 15 N, but the peak is displaced to < 1950 Å, the limit of measurement, in concentrations below 7.5 N. (auth)

32893 (ORNL-3314(p.169-74)) THORIUM OXIDE IRRADIATIONS. (Oak Ridge National Lab., Tenn.).

Code P-82 ThO_2 pellets (1650°C fired) showed little damage after being irradiated three months in the LITR under D_2O at 250°C and dry in Al capsules under a He atmosphere. Average weight loss as a result of the wet-irradiation was 0.4% and of the dry, < 0.05%. Irradiation markedly enhanced the wear resistance of the pellet surfaces, but, once the surface layers were removed during the first one or two hours of a standard spouting bed test, the wear rates of the irradiated materials were comparable to those of the unirradiated pellets. Irradiation in water also produced a small increase in void volume and a large number of small pores probably associated with individual fission events. Metallographs of the unirradiated and wet-irradiated pellets showed essentially no differences. Two series of ThO_2 powders fired at 650, 800, 900, 1100, and 1500°C were irradiated dry in Al capsules for 16 and 22 months in the Low Intensity Test Reactor. The 650, 800, and 900°C-fired oxides became red and sintered into hard, glossy fragments. The 1100°C-fired materials formed off-white, chalky plugs, and the 1500°C fired oxides were blue powders. The specific surface areas of oxide fired at ≤1100°C were markedly decreased by the irradiation although the estimated maximum temperatures of the powders during irradiation were < 1000°C. Little or no sintering, and only slight particle damage occurred in

the 1500°C-fired powders. The sintering probably resulted from recrystallization processes induced by fission fragment irradiation. (auth)

32894 (ORNL-3314(p.175-7)) GAS RECOMBINATION STUDIES. (Oak Ridge National Lab., Tenn.).

A Pd-on-thoria catalyst was developed for use in aqueous reactor slurries to recombine radiolytic deuterium and O_2. At low deuterium partial pressures and under O_2 in excess of the stoichiometric ratio the specific catalytic activity was more than sufficient to recombine the radiolytic gases rapidly with very small concentrations of Pd. Under these conditions the reaction was first order with respect to the deuterium partial pressure and 0.5 order with respect to the O_2 partial pressures respectively. The apparent activation energy for recombination in the temperature range 250 to 280°C was 19 to 26 kcal/mole. Most simulated fission product accumulations did not affect catalytic activity. Definitive correlations between catalytic activities observed in laboratory autoclave experiments and those obtained in pump loop experiments or observed in in-pile autoclave experiments have not been obtained. However, the specific activity based on the Pd concentration of a slurry of solids irradiated in an in-pile pump loop experiment was as high as those obtained with other slurry-Pd catalyst systems which had not been irradiated, indicating that simultaneous reactor irradiation and pumping under O_2 did not decrease catalytic activity. (auth)

32895 (ORNL-3314(p.182-4)) THORIUM RECOVERY FROM ROCKS. (Oak Ridge National Lab., Tenn.).

An extensive survey with a portable gamma-ray spectrometer of over 300 sq miles of surface out-crops of the Conway granite in New Hampshire indicate an average Th content of 56 ± 6 ppm. If this concentration persists with depth, and this will be determined by drilling during the next year, the Th reserves in the Conway formation will amount to tens of millions of tons. The granite contains smaller but significant concentrations of U. Based on studies of 13 different samples, estimated recovery costs of Th plus U ranged from $23 to $83 per pound. Several samples of less extensive granite formations from the New England states contain Th at concentrations equivalent to the Conway. Volcanic rock samples from Italy and Nevada contain 12 to 50 ppm Th but resist acid leaching. Sublateritic soil samples from the southeastern United States contain only 5 to 16 ppm Th. (auth)

32896 (ORNL-3314(p.184-6)) RADIATION EFFECTS ON CATALYSTS. (Oak Ridge National Lab., Tenn.).

Contrary to published data, radioactive $MgSO_4$ and $MgSO_4-Na_2SO_4$ were less effective in the conversion of cyclohexanol to cyclohexene than were the corresponding nonradioactive catalysts. Both radioactive and nonradioactive catalysts lost catalytic activity on aging. (auth)

32897 (ORNL-3314(p.187-90)) HIGH-TEMPERATURE CHEMISTRY. (Oak Ridge National Lab., Tenn.).

Detailed drawings were completed for the spectrometer system designed for operation at temperatures up to 330°C and pressures up to 3000 psi. A miniature loop system was designed and constructed for use at 150°C and 200 psi. A method based on graphical summation of photon contributions from electron energy distributions was developed for calculating Cherenkov radiation intensity from beta- and/or gamma-emitting sources. (auth)

32898 (ORNL-3314(p.190-4)) MECHANISMS OF SEPARATIONS PROCESSES. (Oak Ridge National Lab., Tenn.).

The distribution of HNO_3 between aqueous and TBP-Amsco 125-82 solutions, for all diluent/TBP ratios and up to ~5 M HNO_3 in the aqueous phase, were described mathematically by an equation that can be interpreted in terms of the mean activity coefficients of TBP + TBP·H_2O and TBP·HNO_3 + TBP·HNO_3·H_2O in the organic phase. The same description applies to many literature data. Preliminary transpirational measurements of the vapor pressure of TBP over nearly dry and over water-saturated TBP were obtained to help determine the thermodynamic equilibrium constant for the distribution of HNO_3 between aqueous and TBP–Amsco 125-82 solutions. Partial pressures of HNO_3 over aqueous solutions of 2 to 16 M HNO_3 were determined by the transpirational technique and used to obtain activity coefficients and the thermodynamic constant for dissociation of this acid into the ions H^+ and NO_3^-. Fundamental and applied studies of the foam separation process were continued. Surface tensions of solutions of sodium dodecylbenzene sulfonate containing added H^+, Na^+, Ca^{2+}, or Ce^{3+} ions gave essentially the same value of α ($\alpha = 1.4 \times 10^6$ cm^3/mole), which is a measure of the tendency of a surfactant to concentrate at the solution surface. This is interpreted to mean that the surfactant-cation complexes of all these ions have the same degree of surface activity when expressed in terms of the concentration of the undissociated complex in solution. Screening tests, now essentially complete, showed eight surfactants out of 107 commercial products that warrant detailed study. Each of these could be used over a range of acidities but shows decreasing separation of Sr from solution as the calcium concentration exceeds ~10^{-4} M. Studies of some of the parameters of countercurrent foam columns showed, with dodecylbenzene sulfonate surfactant and ORNL tap water, that the height of a theoretical transfer unit for Sr removal is 1 to 2 cm of foam, thereby requiring only ~1 ft of foam height for good decontamination. Volumetric solution throughputs up to 1.65 gal min^{-1} per ft^3 of foam were achieved. A head-end precipitator to remove Ca and Mg, prior to foam decontamination of low-activity-level waste, also gave a Sr decontamination factor of ~10^2 and a Cs decontamination factor of 10 to 40 when grundite clay was added to the waste to a level of ~0.5 lb per 1000 gal. (auth)

32899 (ORNL-3314(p.195-6)) EQUIPMENT DECONTAMINATION. (Oak Ridge National Lab., Tenn.).

Samples of gas loop piping were spray decontaminated with oxalate-peroxide. Cs^{137} and I^{131} were deposited on metals from high-temperature He and decontaminated by various reagents. The behavior of H_2O_2 as a corrosion accelerator or inhibitor in many types of decontamination solutions was studied. Noncorrosive mixtures effective for at least 12 hr at 95°C in the presence of carbon steel were developed. Other noncorrosive peroxide decontamination solutions effective at lower temperatures were found. The decontamination effectiveness of acidic fluorides, with corrosion inhibited by peroxide, was demonstrated with Pu and Am activity on stainless steel samples. (auth)

32900 (ORNL-3314(p.196-8)) RADIATION DAMAGE TO ION EXCHANGE RESIN. (Oak Ridge National Lab., Tenn.).

After (0.75–0.77) × 10^9 r (2.0–2.1 whr per g of dry resin) irradiation, 10–20% (dry basis) of the cation-exchange resin Dowex 50W was decomposed and dissolved in a flowing stream of water. The specific wet resin volume increased 10 to 15%, but there was no evidence of fissuring or fragmentation. The moisture content increased 10 to 15%. The resin lost 40 to 50% of its original strong acid capacity but gained ~5% weak acid capacity. The S loss was 1.0 to 1.2 atoms/100 ev, and only 75 to 80% of the S remaining on the polymer was present as the active

sulfonate group. Analyses of the collected effluents indicated that degradation products included sulfate, sulfonate, and oxalate in the acid form. Eighty percent of a sample of Dowex 50W X-8 resin dissolved in the water stream, and 95% of its total capacity was lost, after an exposure of 3.9×10^9 r (13.8 whr per g of dry resin). Amberlite 200, a highly cross-linked, porous resin, lost 15% of its weight by an irradiation of 0.97×10^9 r (2.6 whr per g of dry resin), and increased 20% in surface area and 25% in median pore diameter. The total capacity loss was 44%. (auth)

32901 (ORNL-3314(p.199-201)) FUEL SHIPPING STUDIES. (Oak Ridge National Lab., Tenn.).

Prototype fuel shipping casks, weighing 1.5 to 6 tons each, were dropped from heights of from 6 in. to 20 ft onto a drop pad. The casks were instrumented with strain gages, accelerometers, compressometers, and inertia switches to measure strain, deceleration, and deformation. Data obtained in the tests are being correlated for scaleup to full sized casks. The experimental program on dissipation of fission product heat from fuel shipping casks was completed. Mathematical methods developed for predicting maximum temperatures up to 300°C gave results to within 20°C of experimentally determined values. (auth)

32902 (ORNL-3314(p.202-4)) GAS-COOLED REACTOR COOLANT PURIFICATION. (Oak Ridge National Lab., Tenn.).

In a kinetic study of the catalytic oxidation of small amounts of H_2, CO, and CH_4 with O_2 in a bulk He stream, three empirical equations were developed which correlate the data and are suitable for design purposes. A more fundamental study on the oxidation of these contaminants with copper oxide pellets experimentally verified mathematical models based on diffusion through the pellet pores for H_2 and CO and a surface-dependent reaction for CH_4. The differential equations from the models were solved numerically with a high-speed computer. The product water and CO_2 could be easily sorbed on a fixed bed of molecular sieves. The combination of oxidation and sorption is an excellent method for purifying gas coolants of gas-cooled reactors. (auth)

32903 (ORNL-3314(p.204-6)) CHEMICAL ENGINEERING RESEARCH. (Oak Ridge National Lab., Tenn.).

A folded 50-ft-long thermal diffusion column with a cellophane membrane, and with controlled countercurrent flow, was successfully used to separate Co and cupric ions in aqueous sulfate solution. Observed HTU's with a 1-ft-long column were less than those calculated from a slug-flow model. A modification of the stacked-clone high-speed contactor incorporating cylindrical sections achieved 40 to 75% stage efficiencies at throughputs of 1200 to 2000 cc/min with the uranyl nitrate–1 M $NaNO_3$(aq)–18.3% TBP-Amsco system. (auth)

32904 (ORNL-3314(p.207-8)) CANE PROGRAM. (Oak Ridge National Lab., Tenn.).

The sequenced gas samples functioned as designed in the Gnome test. Preliminary work on the hypervelocity jetting of U cones indicated that recovery of irradiated U targets from an underground detonation may be possible. Chemical studies of isotopic exchange of H isotopes in the H_2-water system, with either materials from natural salt formations as catalysts or with high thermal energy from a plasma jet at 10,000 to 12,000°K, indicated that tritium produced by a detonation in salt will be lost to environmental water. Studies of the oxidation of H_2 to water by the sulfates in natural salt show that this mechanism also leads to mixing of tritium with environmental water. (auth)

32905 (ORNL-TM-292) CHEMICAL TECHNOLOGY DIVISION UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT, APRIL 1962. M. E. Whatley, P. A. Haas, R. W. Horton, A. D. Ryon, J. C. Suddath, and C. D. Watson (Oak Ridge National Lab., Tenn.). Oct. 8, 1962. Contract [W-7405-eng-26]. 54p.

Bubble size measurements in the foam column showed that a spinnerette with 50 μ holes gave a nearly normal distribution of bubbles sizes while a coarse fritted glass gas sparger had a tail of large bubbles which did not fit the normal curve. A set of equations solvable by a finite difference technique are presented which completely describe the irreversible reaction rate of H_2 or CO with a fixed bed of CuO pellets. Radiation damage tests are in progress to evaluate plastics for the Transuranium program. All dejacketed SRE Core I U fuel slugs were recanned and shipped to Savannah River. Installation of the shear-leach complex is complete. The shortest practical length into which a tubular fuel element assembly may be sheared appears to be ½ in. Tests showed difficulties with shearing assemblies containing tube sheets. The stepped shear blade used for Mark I prototype fuel elements produced chunks of porcelain filled Yankee prototypes. Flow capacities of nozzle plate pulsed columns operated under dilute Purex flowsheet conditions were determined. Fuel pins made with compacted sol-gel ThO_2 and U^{235} were irradiated without difficulty to 17,000 Mwd/t. Routine operation of the rotary denitrator to give ThO_2 product was demonstrated. (auth)

32906 (UCRL-10377) THE DETERMINATION OF MOLECULAR STRUCTURE FROM ROTATIONAL SPECTRA. Victor W. Laurie and Dudley R. Herschbach (Stanford Univ., Calif. and California. Univ., Berkeley. Lawrence Radiation Lab.). July 1962. Contract W-7405-eng-48. 5p.

An analysis is presented concerning the average molecular configuration variations and their effects on molecular structure determinations. It is noted that the isotopic dependence of the zero-point is often primarily governed by the isotopic variation of the average molecular configuration. (J.R.D.)

32907 (UCRL-10422) HIGH RESOLUTION PROTON MAGNETIC RESONANCE SPECTRA OF SILYLPHOSPHINE, SILYLARSINE, GERMYLPHOSPHINE AND GERMYLARSINE. J. E. Drake and W. L. Jolly (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1962. Contract W-7405-eng-48. 13p.

The proton magnetic resonance spectra of SiH_3PH_2, SiH_3AsH_2, GeH_3PH_2, and GeH_3AsH_2 are described and interpreted. (auth)

32908 (AEC-tr-5392) ORIENTATION PHENOMENA DURING CRYSTAL GROWTH REMOTE FROM PHASE EQUILIBRIUM. Ernst Bauer. Translated for Oak Ridge Gaseous Diffusion Plant, Tenn., from Z. Krist., 107: 290-317(1956). 38p.

The orientations resulting from nucleation and nuclear growth which can be predicted during crystal growth remote from the phase equilibrium are derived from a previously developed model concept on the growth of layers, for a few structures. Orientations resulting from nucleation are discussed for the case of a slight interaction with the matrix. Other orientations are discussed which result from nuclear growth in two boundary cases that are the effects of multidirectional molecular flow. The proposed model concepts are confirmed by investigations of vapor-deposited layers of ion crystals (particularly LiF, CaF_2, and BaF_2). (J.R.D.)

32909 (AEC-tr-5393) STRUCTURE AND GROWTH OF THIN VAPORIZED LAYERS. Ernst Bauer. Translated for Oak Ridge Gaseous Diffusion Plant, Tenn., from Z. Krist., 107: 72-98(1956). 40p.

The relations of condensed-vapor-layer structure with conditions of preparation were investigated. Thin fluoride layers were deposited in high vacuum on various matrices under various parametric conditions such as layer thickness, type of matrix, temperature of the matrix, and direction of deposition. These samples were examined electron microscopically and by electron diffraction. Results were interpreted by use of a growth model developed on the basis of crystal growth theory. In this way, orientation phenomena are explained. These phenomena were subdivided into nucleus-forming and nucleus-growth conditioned orientations. Most observations may be interpreted by the model. (J.R.D.)

32910 A RADIOACTIVE DRUG: 2-METHYL-6-TRITIO-1,4-NAPHTHAQUINOL BIS(DISODIUM PHOSPHATE) AND 2-METHYL-5,6,7-TRITIO-1,4-NAPHTHAQUINOL BIS(DISODIUM PHOSPHATE). K. J. M. Andrews, F. Bultitude, E. A. Evans, M. Gronow, R. W. Lambert, and D. H. Marrian (Cambridge Univ., Eng.; Radiochemical Centre, Amersham, Bucks, Eng.; and Roche Products, Welwyn Garden City, [Eng.]). J. Chem. Soc., 3440-6(Sept. 1962).

2-Methyl-6-tritio-1,4-naphthaquinol bis(disodium phosphate) was prepared by reductive dehalogenation of the corresponding 6-iodo-compound by carrier-free tritium. The product, of specific activity 27 curies per millimole, remained essentially radiochemically pure in aqueous solution for several months. Preliminary laboratory and clinical investigations of the compound as a new form of treatment of human malignancies suggested the need for even higher activity. 5,6,7-Tribromo-2-methyl-1,4-naphthaquinol bis(disodium phosphate) was therefore synthesized and likewise reduced to the tritritio-compound of specific activity 83 curies per millimole. (auth)

32911 REACTIONS INITIATED BY β-DECAY OF TRITIUM. IV. DECAY AND β-LABELING. Kang Yang and Preston L. Gant (Continental Oil Co., Ponca City, Okla.). J. Phys. Chem., 66: 1619-22(Sept. 1962).

The β decay of tritium, $T_2 \rightarrow HeT^+ + e^-$, initiates the reactions forming tritiated hydrocarbons in the system initially composed of gaseous propane and tritium. The L(X) (the labeling yield per decay) for tritiated methane, ethane, and propane increases linearly with increasing tritium concentration: $L(X) = a + b(T_2)$ (1) where a and b are constants and (T_2) denotes total β activity in the sample. These yields decrease when T_2 is replaced by HT, but irradiation with an external gamma source increases them. Nitric oxide eliminates the term $b(T_2)$ in (1) but has no effect on the other term, a. A quantitative explanation is given for these effects based on the division of labeling processes into two parts: HeT^+ ion-initiated reactions and electron-initiated reactions. (auth)

32912 STUDY OF THE SEPARATION OF THORIUM WITH CERIUM EARTHS. P. E. Wenger and I. Kapetanidis. Mikrochim. Acta, 400-10(Jan. 31, 1962). (In French)

A method is described for separation of Th from cerium earths which makes use of complexes formed between Th ions and ethylene glycol-bis(2-aminoethyl ether)-N,N'-tetraacetic acid or 2,2'-diaminoethyl ether-N,N'-tetraacetic acid. The Th complex with the 1st compound was less stable so it is preferred over the 2nd. $Th(NO_3)_4$ was converted from ThO_2, present in the calcined earth, and then to the hydroxide by precipitation with tetramethyl ammonium hydroxide. The latter was used instead of KOH or NaOH since adsorption of K and Na on the precipitated hydroxide occurred with these alkalis. Ce was maintained in the trivalent state by reduction with formaldehyde. Thus, 1 g of the oxide is dissolved in 300 ml water at 100° by addition of 4.5 g of the chelating agent in the acid form plus 15 ml 40% formalin and a few drops of β-naphthol violet solution. The Th complex is unstable at high pH (13 to 13.5), unlike those of La, Ce, Pr, and Nd, and is precipitated by addition of alkali. Application of the method to an artificial monazite showed that recovery of Th was ~99%. (H.H.D.)

Analytical Procedures

Refer also to abstract 33999.

32913 (AAEC/TM-131) AN APPARATUS FOR DIFFERENTIAL THERMAL ANALYSIS AND ITS USE IN THE INVESTIGATION OF SOME BERYLLIUM COMPOUNDS. D. J. O'Connor and D. Roman (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Mar. 1962. 14p.

An apparatus for differential thermal analysis of α-active or toxic materials is described. The technique is superior to thermogravimetric analysis. Analysis of the dehydration of beryllium sulfate shows that the process takes place in three stages. A modified apparatus for quantitative work is also described. (auth)

32914 (AAEC/TM-153) DETERMINATION OF BERYLLIUM, THORIUM, AND URANIUM IN SULPHURIC–PHOSPHORIC ACID MIXTURES. T. M. Florence and P. J. Shirvington (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Sept. 1962. 9p.

Methods are described for the determination of traces of Be, Th, and U in concentrated sulfuric-phosphoric acid mixtures. When the Be concentration is sufficiently high, the chrome azurol S spectrophotometric method may be applied directly, and a small correction made for phosphate interference. At lower concentrations Be should be first separated by an acetylacetone extraction. Th must be separated from sulfate and phosphate before the thoronol spectrophotometric method can be used. This is achieved by precipitating Th as the fluoride, using Y carrier. U may be determined spectrophotometrically with arsenazo after separating Be, Th, sulfate, phosphate, and other impurities by anion-exchange from hydrochloric acid solution. In an alternative procedure, U is reduced to the tetravalent state and precipitated with Th as the fluoride, again using Y carrier. The determination is then completed by a-c polarography. (auth)

32915 (AEET/HP/TM/2) MONITORING OF IODINE-131 IN AIR USING ACTIVATED CHARCOAL. S. K. Mehta and P. Kotrappa (India. Atomic Energy Establishment, Trombay). Jan. 1, 1961. 19p.

I-131 adsorption efficiency of activated charcoal was examined for the purpose of routine I-131 monitoring in air. A standard cartridge consisting of 14 to 22 mesh size charcoal in a 1.5 inch long glass tube of 0.5 inch diameter was designed for sampling I-131 from air. The standard cartridge picks up I-131 with an efficiency of 98% and can be easily counted in a well-type scintillation counter. Air activity of 0.005 mpc can be detected in a 20 minute sample taken with a 40 l/min pump and higher activities in proportionately shorter time. (auth)

32916 (AERE-R-3925) ANALYSIS OF SULPHUR AND COBALT IN HYDROCARBONS USING A ^{147}Pm/Al BREMS-

STRAHLUNG SOURCE. J. R. Rhodes, T. Florkowski, and J. F. Cameron (United Kingdom Atomic Energy Authority. Research Group. Wantage Research Lab., Wantage, Berks, England). Aug. 1962. 32p.

A radioisotope x-ray-absorption method is described for measuring the S content of petroleum products in the range 0.03 to 6% independent of the C-H_2 ratio. The sensitivity of the S analysis is found to be equal to those quoted for other x-ray-absorption methods. Two examples of radioisotope x-ray-fluorescence analysis are also described for the determination of the Co content of hydrocarbons in the range 0.001 to 2%, independent of trace quantities of Fe. In one of the examples the use of differential-x-ray-filters to increase the sensitivity is described. With this technique determination of Co contents in the range 10 to 1000 ppm is possible. A comparison of the radioisotope-x-ray-absorption and x-ray-fluorescence techniques for analysis of Co in hydrocarbons is included. (auth)

32917 (ASD-TR-61-654) RESEARCH ON THE FEASIBILITY OF PROPELLANT DETECTION BY INDUCED RADIOACTIVE TECHNIQUES. Frederick J. Brousaides, Richard Bersin, James C. McCue, Carlton O. Hommel, and David J. MacDonald (Tracerlab, Inc., Waltham, Mass.). Dec. 1961. Contract AF33(616)-7846. 68p. (AD-273262)

The feasibility of detecting small quantities of toxic propellants in the atmosphere by utilizing the decay characteristics of radioactive materials was studied. Activation analysis and inverse radioactive tracer techniques were used. The latter may be defined as processes in which a constituent to be analyzed undergoes a reaction (or reactions) which results in the ultimate release of a radioactive tracer gas whose concentration is proportional to the original constituent to be analyzed. Toxic materials selected for investigation included nitrogen dioxide, hydrazine, unsymmetrical dimethyl hydrazine, boron hydrides, and beryllium oxide. Emphasis was placed upon the use of Kr^{85} quinol clathrates for the detection systems. Properly controlled, these systems were found to be selective to a narrow band of Redox materials and gave predictable responses to toxic gas concentrations. (auth)

32918 (CRRP-1099) AN IMPROVED INFRA-RED METHOD OF MONITORING HEAVY WATER. J. G. Bayly, R. J. Booth, and W. H. Stevens (Atomic Energy of Canada, Ltd., Chalk River, Ont.). July 1962. 17p.

A design for an instrument to analyze liquids by automatically measuring their infrared absorption at two or more wavelengths is presented. The instrument was specifically designed for monitoring the isotopic purity of heavy water. Changes of ten parts per million in the D/H ratio of heavy water can be detected. The basic instrument can also be used to detect changes in the deuterium content of ordinary water in the natural concentration range. With auxiliary equipment for extracting moisture from the air, the instrument can monitor the heavy water content of the air. When this heavy water contains a known concentration of tritium, the instrument can serve as a tritium monitor with the advantage that it is uninfluenced by other radioactive contaminants in the air. (auth)

32919 (HW-SA-2693) A DATA LOGGING ABSORPTIOMETER FOR ROUTINE URANIUM ANALYSIS. N. P. Wilburn and W. L. Nicholson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 10, 1962. Contract AT(45-1)-1350. 46p.

A method was developed for determination of uranium concentrations in aqueous and organic phases by means of a data-logging gamma absorptiometer. An americium source is used which emits gamma photons of 60-kev energy at a rate of approximately 2.8×10^{10} γ/min. Five sample cells are used. A scintillation detector gives a current proportional to the number of photons transmitted by the sample cell. Two voltages are read for each sample cell: the phototube output and a constant source. Each voltage logged on the printed tape has recorded with it a 3 digit identification which contains information as to what type of solution is being analyzed, what size sample cell was used, and from which sample part in the pulse column test facility the sample was obtained. The printer tape is identified and submitted to the data processing section to be key punched into cards. The cards are processed with a data reduction code to give actual concentrations. An average of 30 run samples per 8 hr day was achieved using the apparatus. (M.C.G.)

32920 (NYO-10171) RESEARCH IN ACTIVATION ANALYSIS. Quarterly Progress Report, April–August 1962. Henry H. Kramer, Victor J. Molinski, Werner H. Wahl, and Paul M. Stier (Union Carbide Nuclear Co. Research Center, Tuxedo, N. Y.). Sept. 19, 1962. Contract AT(30-1)-2975. 13p.

The experimental work completed thus far in the areas of rapid radiochemical separations and metastable isomeric states is summarized. Activation analyses were made in samples of ore materials and metals using rapid radiochemical separations to isolate short-lived radioactive isotopes such as 3.77-min V^{52} and 14.6-min Mo^{101}. The analytical results obtained were compared to the results obtained from standard chemical and instrumental analytical methods and, where possible, to activation analysis results obtained from longer-lived isotopes of the same element. Further work is in progress to improve the procedures, to evaluate the reproducibility and accuracy of the methods, and to evaluate their usefulness on a wide variety of sample matrices. The research on short-lived metastable isomers showed that 1.7-min W^{185m} is not produced in sufficiently high yield for the development of a supplementary analytical scheme for natural tungsten although it could be used for isotope ratio determinations in certain enriched samples. Results on the decay of W^{185m} are in good agreement with studies of the isomer produced by photodisintegration and high energy neutron bombardment although they do suggest some error in the published values of the energies of the gamma rays emitted in the decay. Preliminary results indicate that 1.1-hour Pb^{204m}, which is produced in a nuclear reactor by both inelastic neutron scattering and photoexcitation, will provide a satisfactory basis for the activation analysis of lead. (auth)

32921 (PAN-312/VIII) SPECTRAL ANALYSIS BY THE POWDER SIFTING METHOD. PART III. THE "ADDITION AND DIVISION" METHOD. Julian Czakow and Jerzy Minczewski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Mar. 1962. 14p.

An improved method of "addition and division" was worked out for spectrographic determination of traces of elements by extrapolation. This method is particularly suitable for the powder sifting technique by means of a Cu sifter electrode. The concentration of the element x is computed from $x = (z/2^b - 1)$, where x is unknown concentration of the determined element and z is the addition to the sample of the known amount of the determined element. (auth)

32922 (CEA-tr-A-1032) L'ANALYSE SPECTRALE PAR FLUORESCENCE AUX RAYONS X D'ÉCHANTILLONS GÉOCHIMIQUES POUR DES ÉLÉMENTS DE NOMBRES ATOMIQUES COMPRIS ENTRE 25 ET 40. (X-Ray Fluorescence Spectral Analysis of Geochemical Samples of Elements of Atomic Number 25 to 40). K. H.

Wedepohl. Translated into French from Z. Anal. Chem., 180: 246-59(1961). 36p.

For comparisons with other corresponding methods the essential characteristics of x-ray fluorescence spectral analysis are summarized. In order to obtain optimal conditions for analysis there are choices between tubes with different anodes, between analyzer crystals, and radiation receivers. Among the most frequently used are: tungsten tubes, LiF crystals, and scintillation counters. After the review of qualitative analyses, the quantitative analyses are thoroughly described. As the necessary internal standards As(K_α) was suitable for analysis of Fe, Ni, Cu, and Zn, and Mo(K_α) for Br, Rb, Sr, Y, and Zr. Oxides of these standard elements were mixed in concentrations of 0.1 or 1% in the materials to be analyzed. The plotting of calibration and correction curves is shown for examples. For quantitative trace analysis, calculations can be made with an average relative error of ±3 to 10%. For iron determination at concentrations of X% this error is ±2.5%. The error of a duplicate determination (±1.8%) corresponds to a single chemical determination. (tr-auth)

32923 CATALYTIC ANALYSIS. I. DETECTION OF SUBMICRO QUANTITIES OF COBALT WITH THE USE OF THE REACTION TIRON–HYDROGEN PEROXIDE AND TIRON–2,7-DIHYDROXYNAPHTHALENE–HYDROGEN PEROXIDE, RESPECTIVELY. J. Bognár and O. Jellinek (Technical Univ. for Heavy Industry, Miskole, Hungary). Acta Chim. Acad. Sci. Hung., 29: 21-33(1961). (In English)

Two extremely sensitive catalytic reactions suitable for the detection of submicro amounts of cobalt are presented. Cobalt(II) ions proved to catalyze the oxidation of tiron by hydrogen peroxide in a slightly alkaline medium. On utilizing this catalytic effect, it is possible to detect 10^{-4} μg of cobalt(II) ions at a dilution limit of $1:5 \times 10^{10}$. The reaction rate discloses a maximum at pH 10.6. Cobalt(II) ions similarly show a strong catalytic effect in the redoxy system tiron–2,7-dihydroxynaphthalene–hydrogen peroxide. By this reaction, 5×10^{-3} μg of cobalt(II) ions can be detected at a dilution limit of $1:10^{11}$. The optimum pH of this reaction ranges 9.0 to 10.5. The catalytic effect proved to depend on various parameters (concentration of reagents, pH values, temperature). The suggested reactions are suited for use also in the presence of alien ions at adequate conditions of concentration. The presence of nickel(II) and OsO_4 interferes with the reaction, due to the catalytic action of these ions. (auth)

32924 IDENTIFICATION OF METALS IN TATTOO MARKS BY ACTIVATION ANALYSIS WITH GAMMA SPECTROMETRY. E. Berne, A. Bjoernberg, B. Rosengren, and E. Skjelbred (Univ. of Göteborg). Acta Dermato-Venereol., 42: 149-52(1962).

This method was used to detect Cr, Hg, and Co in tattoo marks in human skin for an investigation of the relation of the presence of these metals to allergic reactions in skin. Ashed skin samples and K_2CrO_4 were irradiated under identical conditions with a flux of 5.8×10^{11} neutrons per cm^2 per sec. After products having a short half life (Na^{24} and K^{42}) were allowed to decay almost completely, or ~2 weeks, the ratio of gamma radiation of skin ash/K_2CrO_4 became constant, indicating the similarity of half-life times in the 2 substances. The presence of the same radioactive substance in the 2 samples was confirmed by use of single-channel scintillation spectrometer. Thus the tattoo ash was demonstrated to contain Cr^{51}. Hg and Co were similarly detected by making use of the nuclear reactions $Hg^{202}(n,\gamma)Hg^{203}$ and $Co^{59}(n,\gamma)Co^{60}$. (H.H.D.)

32925 DETERMINATION OF THE ISOTOPIC COMPOSITION OF A β-EMITTING GAS MIXTURE BY MEANS OF TWO INTERCONNECTED IONIZATION CHAMBERS. A. D. Turkin and Yu. V. Sobakin. At. Energ. (USSR), 13: 274-6 (Sept. 1962). (In Russian)

The usual method of determining β-active gases in the atmosphere by recording the decay curve of the sample is rendered difficult if the half lives of the isotopes are too close to each other. The isotopic composition of the mixture can be determined more accurately by making use of a second parameter, the limiting energy of the β spectrum. This may be derived from the back scattering of β particles; the value of the back scattering is a direct function of the order number of the reflector. Thus, if 2 interconnected ionization chambers, with walls made of different materials, are employed for the measurements, the ionization currents generated will be different. Two spherical chambers with walls made of Pb and Plexiglas were constructed for this purpose. The concentration of an isotope Q in curie/liter was calculated from the expression Q = kI where I indicates the ionization current and k the standardization coefficient, the latter being a function of the β spectrum. (TTT)

32926 A MEASUREMENT SYSTEM FOR CONTINUOUS DETERMINATION OF C^{14} ACTIVITY AND CO_2 CONCENTRATION IN EXPIRED AIR. C. von Holt and H. Schmidt (Universität, Hamburg). Biochem. Z., 334: 516-23(Aug. 11, 1961). (In German)

Two measuring systems are described, one for use with small laboratory animals and one for human subjects. In the 1st apparatus the animal, injected with a C^{14}-labeled metabolite, is enclosed in a glass chamber from which the gas is pumped through a drying tube. From this tube it passes through an ionization chamber, an infrared measuring cell (for determining CO_2 concentration), and a flowmeter. For measurements in humans, a face mask equipped with an inlet and outlet valve is used, from which expired gas is collected in a rubber bag and then passes through the drying tube, ionization chamber, infrared cell, and flowmeter. The signal from the ionization chamber is amplified electronically for automatic registration and the signal from the infrared cell is linearized, since it is not initially proportional to CO_2 concentration. Applications of both systems are described and illustrated. (H.H.D.)

32927 RAPID METHOD FOR THE DETERMINATION OF PLUTONIUM IN RADIOACTIVE EFFLUENTS. J. Scheidhauer (Centre de Marcoule, France) and L. Messainguiral. Chim. Anal. (Paris), 43: 462-64(1961).

Plutonium was separated from other active constituents by co-precipitation with LaF_3, subsequent reduction to Pu(IV) and extraction with 2-thenoyltrifluoroacetone in xylene; the organic extract was evaporated to dryness and ashed before final determination of the α activity with a scintillation counter. If large amounts of Ca are known to be present (>200 mg per liter), they may be removed by precipitation as CaF_2 from solution containing Pu as Pu(IV), and the Pu is subsequently reduced to Pu(IV) and extracted from the solution with 2-thenoyltrifluoroacetone as described. A precision of ±5% is reported for 1 to 5×10^{-4} μC of Pu. (Public Health Eng. Abstr., 42: No. 9, Sept. 1962)

32928 DETERMINATION OF CARBON AND ITS RADIOACTIVITY. IV. TRANSFER OF CO_2 TO COUNTING TUBES WITHOUT USE OF LIQUID NITROGEN. Donald D. Van Slyke and John Plazin (Brookhaven National Lab., Upton, N. Y.). J. Biol. Chem., 237: 3296-8(Oct. 1962). (BNL-6144)

The method of Van Slyke, Steele, and Plazin for measur-

ing CO_2 in a manometric chamber and then passing the CO_2 into a Bernstein-Ballentine counter can be simplified by omission of chilling the counter in liquid nitrogen. Methane or P-10 gas (90% argon, 10% methane), passed first into the manometric chamber, then into the counter, completely washes CO_2 into the counter with the latter at room temperature. Applications in counting $C^{14}O_2$ are discussed. (C.H.)

32929 AN AUTOMATIC MEASUREMENT OF RADIOACTIVE CHROMATOGRAMS ON STRIPS OF PAPER. J. Fouarge (Laboratoire de Chimie Nucleaire, Liege). J. Chromatog., 9: 96-105(Sept. 1962). (In French)

An apparatus is described in which a unit identical to that of the graphic recorder is used to move the chromatograms successively under the counter tube; the record is of a conveniently reduced size. An endless strip made of cellulose acetate carries up to 15 paper bands of 20 to 25 cm effective length, arranged on 5 tracks at a distance of 2.5 cm from each other, or 3 bands of 50 to 80 cm effective length, arranged on 3 tracks spaced at 4 cm. After scanning one track, the counter tube with its lead casing moves sideways to the next track. The rest of the set-up is classical; it consists of a ratemeter connected to a not too expensive rectilinear pen recorder of the moving coil type. (auth)

32930 CONTINUOUS ELECTROPHORETIC SEPARATIONS OF RADIOACTIVE RARE EARTH MIXTURES. III. SURVEY OF EXPERIMENTS IN 0.05 M LACTIC ACID. Z. Pučar and Z. Konrad-Jakovac (Institute Rudjer Bošković, Zagreb). J. Chromatog., 9: 106-10(Sept. 1962). (In English).

Using continuous electrophoresis the relative mobilities of rare earths in 0.05 M lactic acid were estimated. Within the series of rare earths with atomic numbers ranging from 57 to 71, a relationship was found between the cathodic mobilities of these rare earths and their atomic numbers, or their ionic radii respectively. This relationship is presented in diagrams which give straight lines. In the direction of increasing atomic number, or decreasing ionic radius respectively, the cathodic mobility decreases, indicating that the capacity of these rare earths to form complexes with lactic acid increases. At the same time information about the continuous electrophoretic separability of rare earth mixtures in 0.05 M lactic acid for preparative purposes is given. Various problems concerning the determination of relative mobilities using the continuous electrophoretic method are discussed in detail. (auth)

32931 APPLICATION OF ACTIVATION ANALYSIS TO THE DETERMINATION OF TRACE-ELEMENT CONCENTRATIONS IN MEAT. R. C. Koch (Nuclear Science Engineering Corp., Pittsburgh). J. Food Sci., 27: 309-20 (May-June 1962).

The concentrations of 27 trace elements were determined in 4 meats: beef, pork, ham, and chicken. Because the concentrations of most of the elements were expected to be very small, the extremely sensitive method of neutron activation analysis was used. Qualitative analyses were performed for 8 of the elements, and the concentrations of 19 elements were determined quantitatively. The quantitatively measured concentrations varied from ~0.1% for phosphorus to $\sim 10^{-8}$ ppm for cerium. Most data were estimated to be accurate to ±10%. The results demonstrate the applicability of this analytical method to determine inorganic constituents in foods and related substances at a constant level of accuracy throughout the concentration ranges of practical interest. (Public Health Eng. Abstr., 42: No. 9, Sept. 1962)

32932 SPECTROGRAPHIC DETERMINATION OF BORON, ALUMINIUM, IRON, CHROMIUM, MANGANESE IN URANIUM COMPOUNDS. R. De Leone, L. Lorenzini, and C. Stoppa (Comitato Nazionale per l'Energia Nucleare, Milan). Met. ital., 54: 333-40(Aug. 1962). (In Italian)

The analysis of the uranium metal impurities is made with the carrier distillation method. The samples to be analyzed and converted to the refractory oxide U_3O_8 are excited in a continuous current arc after mixing with a suitable carrier. Ga_2O_3 and NaF were tested as carriers and the volatization curves of some elements were obtained. The standards for B, Al, Fe, Mn, and Cr were then prepared and subsequently the working curves were drawn by the external standard method. A comparison was made for Fe using as carrier Ga_2O_3 and NaF and the working curves were drawn using both internal and external standard methods. The results obtained demonstrate the feasibility of quantitative determinations of the above elements by the external standard method, and standard deviations are lower than 10%. (auth)

32933 RESEARCH ON SOME METHODS OF COLORIMETRY TO DETERMINE HAFNIUM IN PRESENCE OF ZIRCONIUM. E. Crepaz, L. Marchesini, and G. Mazzolini (Universitá Padua). Met. ital., 54: 373-9(Aug. 1962). (In Italian)

Research was conducted on the use of some reagents for the spectral determination of solutions of zirconium and hafnium. The behavior of lacquers composed by two cations with phenylfluoron, gallein, R eriocromocianin, thoron, and S alizarin was studied. The best analysis results were obtained by S alizarin. Some considerations were made on results obtained and some possibilities of improvement of the analytic method are discussed. (auth)

32934 SEPARATION AND SPECTROPHOTOMETRIC AND SPECTROGRAPHIC DETERMINATION OF SOME RARE EARTHS IN URANIUM COMPOUNDS. L. Lorenzini, C. Stoppa, and W. Barbieri (Comitato Nazionale per l'Energia Nucleare, Milan). Met. ital., 54: 380-6(Aug. 1962). (In Italian)

After the extraction of uranium with TIOA 0.5 M in xylene from strongly chloride solutions, two methods are proposed to isolate the rare earths from other interfering ions: a) extraction of lanthanides by employing TTA in xylene at 60°C; b) chromatography on anionic resin in sulfuric solutions. The rare earths are altogether determined by a spectrophotometric procedure using arsenazo; in a controlled atmosphere it is possible to carry out a quantitative spectrographic determination arcing the fluorides. The procedure for the determination of Gd, Sm, Dy, and Er is described. (auth)

32935 SPECTROPHOTOMETRIC DETERMINATION OF SILICON IN URANIUM COMPOUNDS. L. Lorenzini, C. Stoppa, and W. Barbieri (Comitato Nazionale per l'Energia Nucleare, Milan). Met. ital., 54: 387-8(Aug. 1962). (In Italian)

On the basis of the colorimetric determination of silicon by the yellow silicomolybdic acid formation or by its reduction to molybdenum blue, three methods for the determination of the silicon in uranium are proposed. Silicon was determined in the solution employing the above methods after extraction of the uranyl nitrate by TBP. Finally a direct uranium determination was carried out using ammonium molybdate, dissolving the precipitated uranyl molybdate with tartaric acid and reducing the molybdate to molybdenum blue. (auth)

32936 DETERMINATION OF RUBIDIUM AND CESIUM BY NEUTRON ACTIVATION FOLLOWED BY GAMMA SPECTROMETRY. Noboru Yamagata (Inst. of Public Health, Tokyo), Kiyoshi Iwashima, and Eisaku Tajima. Nippon Genshiryoku Gakkaishi, 4: 534-9(Aug. 1962).

A rapid method for the determination of rubidium and cesium was developed comprising neutron irradiation, separation by an inorganic ion-exchanger, and γ spectrometric measurement. Another method with preliminary concentration preceding irradiation is also described. These methods were conveniently applied to the determination of rubidium and cesium in a variety of samples of geochemical interests. (auth)

32937 METHODS OF HIGH-TEMPERATURE THERMAL ANALYSIS OF OXIDE SYSTEMS. P. P. Budnikov and S. G. Tresvyatskii. Poroshkovaya Met., No. 1, 75-81 (1961).

An apparatus is described for high-temperature thermal analysis at 1500-2400°C of highly refractory oxides which in the molten state in an environment of purified He, Ar, and N_2 do not react with Mo (BeO, MgO, CaO, SrO, Al_2O_3, Co_2O_3, and the oxides of the rare earth metals). The apparatus represents a vertical furnace with a graphite heater. A special feature of the construction is the use of a W-Mo thermocouple in which a small Mo cup 10-12 mm diameter and 0.2-0.4 g by weight is placed in the junction where the oxides being investigated are placed. The method of operation with such apparatus is described in detail and the analysis of the possible errors is given. (Referativnyy Zhurnal, Metallurgiya, No. 1, 1962)

32938 THE INFLUENCE OF AgCl AND Ga_2O_3 AS "SPECTROSCOPIC CARRIERS" ON DISTILLATION OF TRACE IMPURITIES FROM SPECTROGRAPHIC SAMPLES. L. Pszonicki and J. Minczewski (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Spectrochim. Acta, 18: 1325-36(Oct. 1962).

The term "spectroscopic carrier" has been defined in the present meaning as used by several authors. As an investigation on the mechanism of carrier action, a method of preliminary distillation of impurities from the sample in a special apparatus was employed. Conditions of distillation can be regarded as a model for these which are found in the electrode during direct distillation in a d-c arc. It was found that in several instances the carrier can take part in the distillation of impurities and makes it possible to remove a species which is difficult to volatilize. Often the carrier has a pronounced effect on chemical processes occurring in the electrode. The most advantageous carrier, as regards both quality and quantity, is defined not only by the kind of samples being studied and impurities being determined but also by the temperature of distillation. Investigations were performed on uranium samples. (auth)

32939 DETERMINATION OF MAJOR AND MINOR ALKALIES IN SILICATES BY DIFFERENTIAL FLAME SPECTROPHOTOMETRY. C. O. Ingamells (Pennsylvania State Univ., University Park). Talanta, 9: 781-93(Sept. 1962). (In English)

By attaching an external galvanometer circuit to a Beckman DU spectrophotometer and making use of an improved and highly stable air-natural gas flame, it is possible to apply the principle of differential measurement to the flame spectrophotometric determination of the major and minor alkalies and alkaline earths. Although it is doubtful that any reasonably rapid, purely flame photometric, method can ever equal the best flame-supported gravimetric techniques in determinations of major alkali constituents, procedures were worked out whereby rubidium and cesium can be determined with improved precision, and the accuracy of sodium and potassium determinations is significantly increased. (auth)

32940 DETERMINATION OF ANTIMONY IN LEAD BY NEUTRON-ACTIVATION ANALYSIS. F. Adams and J. Hoste (Ghent Univ.). Talanta, 9: 827-34(Oct. 1962).

Activation analysis of antimony in lead was studied in the concentration range of 1 to 0·03%. Gold is used as a standard so as to avoid self-shielding problems of the antimony standard. The proposed technique is possible by making use of net photospectra and computing the antimony content directly from the ratio of the 0.40- and 0.56-gamma peaks of Au^{198} and Sb^{122}. (auth)

32941 NEUTRON ACTIVATION ANALYSIS AND ITS MEASURING TECHNIQUE. F. Baumgaertner (Technische Hochschule, Munich). Telefunken Ztg., 35: 3-6(Mar. 1962). (In German)

The techniques and possibilities of activation analysis are outlined, and experiments made at the Technical University of Munich are described. Activation analysis is a valuable tool as it is free of errors caused by trace contaminations, and it is suitable for both quantitative and qualitative analyses. Three methods are described in detail for testing the activity purity-testing the constant specific activity, recording the drop in activity as a function of time, and the spectroscopic examination of gamma rays. Sample spectra are given. (auth)

32942 THE PRESENT STATE OF THE ANALYTICAL CHEMISTRY OF LITHIUM, RUBIDIUM AND CESIUM. N. S. Poluektov and V. T. Mishchenko. p.37-56 of "Metody Opredeleniya i Analiza Redk. Elementov." Moscow, Publishing House of the Academy of Sciences, 1961.

Qualitative reactions and methods of isolation, separation, and determination are described. 269 references are included. (Referativnyy Zhurnal, Metallurgiya, No. 1, 1962)

32943 THE PRESENT STATE OF THE ANALYTICAL CHEMISTRY OF BERYLLIUM. V. G. Goryushina. p.79-107 of "Metody Opredeleniya a Analiza Redk. Elementov." Moscow Publishing House of the Academy of Sciences, 1961.

Descriptions of methods are given for the determination of Be in ores, minerals, ore concentrates, Cu, Ni, and Nb alloys, raw materials, and hydrometallurgical products. 66 references are included. (P.C.H.)

32944 THE PRESENT STATE OF THE ANALYTICAL CHEMISTRY OF STRONTIUM. N. S. Poluektov and V. T. Mishchenko. p.108-27 of "Metody Opredeleniya i Analiza Redk. Elementov." Moscow, Publishing House of the Academy of Sciences, 1961.

A review is given on: qualitative reactions on Sr; methods of separation and determination; flame-photometric determination in minerals, ores, and rocks; chemico-spectral determination of admixtures in Sr and Ba; and flame-photometric determination of Ca in salts of Sr. 275 references are included. (Referativnyy Zhurnal, Metallurgiya, No. 1, 1962)

32945 THE PRESENT STATE OF THE ANALYTICAL CHEMISTRY OF THE RARE-EARTH ELEMENTS, SCANDIUM, AND YTTRIUM. D. I. Ryabchikov and V. A. Ryabukhin. p.128-81 of "Metody Opredeleniya i Analiza Redk. Elementov." Moscow, Publishing House of the Academy of Sciences, 1961.

Methods are given for the determination and separation of the rare earths and Y and Sc in soils, rocks, phosphorites, alloys, and concentrates. The spectral determination of Pb, Sn, Cd, and Bi in Ce and La and the flame-photometric determination of Ca in salts of rare earths are also given. 206 references are included. (P.C.H.)

32946 THE PRESENT STATE OF THE ANALYTICAL CHEMISTRY OF THORIUM. D. I. Ryabchikov and Ye. K. Korchemnaya. p.374-99 of "Metody Opredeleniya i Analiza Redk. Elementov." Moscow, Publishing House of the Academy of Sciences, 1961.

Methods are described for the following: determination and separation from Fe, Al, Pb, Cr, Ca, Sr, Ba, Zn, Be, Ga, Mn, Nb, and Ta: determination in ores and alloys; determination of admixtures in Th; emanation methods for the determination of Th in minerals, rocks, and soils; determination of Th in monazite with phytic acid; direct photometric determination in rocks with arsenazo III; trilonometric and photometric methods of determination of Th in minerals and ores; ion-exchange trilonometric determination of Th in monazite concentrates; determination of admixtures in Th compounds by the vacuum evaporation method; and luminescent determination of small amounts of Ga, Sm, and Eu in Th. 286 references are included. (Referativnyy Zhurnal, Metallurgiya, No. 1, 1962)

32947 THE PRESENT STATE OF THE ANALYTICAL CHEMISTRY OF MOLYBDENUM. A. I. Busev. p.537-79 of "Metody Opredeleniya i Analiza Redk. Elementov." Moscow, Publishing House of the Academy of Sciences, 1961.

Descriptions of methods are given for the determination of Mo and W in silicate rocks and minerals, alloys, concentrates, ferromolybdenum, ferrotungsten, steel, and sodium tungstate. The determination of various elements in Mo and W are also given. 175 references are included. (P.C.H.)

32948 NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,246,060. Oct. 3, 1960.

A carbon dioxide cooled reactor having a moderator penetrated by channels charged with fuel elements is provided with means for comparing the general carbon monoxide content of the coolant with the carbon monoxide content emerging from selected channels. These means comprise a multi-selection valve, sampling pipes leading from the fuel element channels to the inlets of the multi-selection valve, a differential infrared gas analyzer having a reference and a sample tube, a pipe connection from the outlets of the valve to the sample tube of the infrared gas analyzer, a further sampling pipe from the reactor containment vessel to the reference tube of the infrared gas analyzer, exit pipes from the sample tube, and a common pipe connecting with the exit pipes and the containment vessel. (NPO)

General Inorganic and Physical Chemistry

32949 (ANL-6594) THE SPECIFIC HEAT OF DYSPROSIUM METAL BETWEEN 0.4° AND 4°K (thesis). Raymond Adolph Guenther (Argonne National Lab., Ill.). Aug. 1962. Contract W-31-109-eng-38. 30p.

Submitted to Illinois Inst. of Tech., Chicago.

A He^3 cryostat was built to measure the specific heat of rare earth metals which have a component, at low temperatures, attributable to the electrons in the incomplete 4f shell. The specific heat of dysprosium from 0.4 to 4.2°K was measured. Pertinent theories about specific heats are outlined. The apparatus included the cryostat, vacuum and He^3 systems, calorimeter, carbon thermometer, heater, and magnetic thermometer. The experimental procedure is described and results are presented in graphic and tabular form. The specific heat rose sharply below 1°K. An anomalous hump was centered about 2.35°K. (M.C.G.)

32950 (HW-SA-2639) DETERMINATION OF CRYSTAL LATTICE CONSTANTS WITH AN X-RAY SPECTROMETER. M. C. Lambert (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [June 13, 1962]. Contract AT(45-1)-1350. 12p.

Use of an x-ray spectrometer in determination of the lattice dimensions of a crystal is discussed. Principles of the method are outlined. Instrumentation, alignment, and techniques are described. Results for UO_2 were obtained using both the internal standard method and extrapolation method. (M.C.G.)

32951 (NAA-SR-Memo-7497) CARBON TRANSPORT FROM RUPTURED MODERATOR CAN INTO SODIUM. E. U. Vaughan (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 25, 1962. Contract [AT-11-1-GEN-8]. 11p.

The equation for diffusion of carbon in sodium, including a transport term arising from the flow, is solved in the region so near the rupture that the parabolic sodium-velocity profile is represented adequately by its tangent. The assumption thus involved is that the carbon is carried away so rapidly that its concentration falls to a very low value before the parabola departs very far from the tangent. If this assumption is inaccurate, the result is an overestimate of the rate at which carbon dissolves. (auth)

32952 (ORNL-3323) THE PREPARATION OF HIGH-PURITY BERYLLIUM OXIDE THROUGH THE ACETYLACETONE-EDTA SOLVENT EXTRACTION PROCESS. R. E. Moore, J. H. Shaffer, and H. F. McDuffie (Oak Ridge National Lab., Tenn.). Sept. 27, 1962. Contract W-7405-eng-26. 33p.

A solvent extraction process was devised and used successfully in the preparation of high-purity BeO. A small-scale production operation was demonstrated. The process consists of extracting a solution of beryllium acetylacetonate in CCl_4 with an aqueous solution containing EDTA. Beryllium is largely retained in the organic phase while most metallic impurities are complexed with EDTA in the aqueous phase. The beryllium is subsequently back-extracted into nitric acid, precipitated as hydroxide with ammonia, and calcined to purified BeO at 600 to 1000°C. Altogether, about 1414 g of high-purity oxide was prepared in 23 analyzed batches. If all of these 23 batches were blended, the composite would contain less than 5 ppm each of aluminum, iron, copper, and magnesium and less than 10 ppm each of calcium and silicon. In nearly all of the preparations the other metallic impurities were below the quantitatively detectable limit (5 or 10 ppm) for most elements of the spectrographic analysis. Several batches were used in the preparation of spectrographic standards for low-level analysis. Other batches are scheduled for sintering studies and irradiation experiments. Distribution ratio vs pH curves for beryllium and several important impurities, the phase diagram of the system $Be(CH_3COCHCOCH_3)_2$-$CH_3COCH_2COCH_3$-CCl_4 at 27°C, and details of the purification procedure are given. The possible preparation of very much higher purity BeO and the possibility of using the process for the preparation of other high-purity materials such as Al_2O_3 are discussed. (auth)

32953 (PWAC-376) THE ELECTRICAL RESISTIVITY OF SODIUM, POTASSIUM, RUBIDIUM AND CESIUM IN THE LIQUID STATE. Samuel M. Kapelner and William D. Bratton (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). June 30, 1962. Contract AT(30-1)-2789. 31p.

The electrical resistivities of sodium (to 853°C), potassium (to 764°C), rubidium (to 752°C), and cesium (to 877°C) were measured by means of a high precision modified Kelvin bridge circuit. Expressions for the electrical re-

sistivity as a function of temperature were derived by a least squares fit of the data. It was found that with the exception of lithium, the electrical resistivity of an alkali metal is proportional to its atomic number at all temperatures. The thermal conductivity of rubidium and cesium were calculated over the temperature range by means of the Wiedemann-Franz-Lorenz equation. (auth)

32954 (AEC-tr-5388) DISSOCIATION EQUILIBRIA OF CHROMIUM NITRIDES. Kokichi Sano. Translated from J. Chem. Soc. Japan, 58: 981-4(1937). 8p.

The relationships between dissociation pressure and temperature for Cr_2N and CrN were found to be: ($Cr_2N \rightarrow 2Cr + \frac{1}{2}N_2$) $\log P_{N_2} = (-9,558.311/T) + 8.1034$ and ($2CrN \rightarrow Cr_2N + \frac{1}{2}N_2$) $\log P_{N_2} = (-12,071.25/T) + 10.6546$. The heat of formation and free energy were found to be −20,602 and 17.262 cal respectively for Cr_2N and −24,298 and −19,545 cal respectively for CrN. The entropies were calculated to be 22.9 eu for Cr_2N and 12.6 eu for CrN. (auth)

32955 (AEC-tr-5397) ELECTRON LEVELS OF TRIVALENT ERBIUM IONS UP TO 40,000 cm^{-1}. S. Hufner. Translated for Ames Lab., Ames, Iowa from Z. Physik, 168: 74-80(1962). 11p.

The absorption spectrum of erbium ethyl sulfate and of erbium chloride in crystalline states was detected in the ultraviolet range of the spectrum at temperatures of 4.2 and 77°K. Association between the experimentally determined and the theoretically calculated electron levels was possible up to an energy of 40,000 cm^{-1}. (auth)

32956 (AEC-tr-5412) THE NATURE OF OXYGEN IN LIQUID SODIUM. (Priroda Kisloroda v Zhidkom Natrii). B. A. Nevzorov. Translated from IAEA Preprint No. CN-13/40 presented at the Conference on the Corrosion of Reactor Materials, Salzburg, June 4-9, 1962. 17p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, as abstract no. 22159.

32957 (EURAEC-233) PREPARATION OF UO_2 POWDERS UNDER WET CONDITIONS. Quarterly Report No. 3, July 1−September 30, 1961. (Italy. Comitato Nazionale per l'Energia Nucleare, Rome). Work Performed under United States−Euratom Joint Research and Development Program. Contract 028-60-10-RD1. 29p. A Translation.

The characteristics of precipitated uranium hydroxides prepared at 20, 40, and 60°C in solutions of ammonium hydroxide at pH 5 and 9 and those obtained using ammonia gas at 20, 170, and 280°C were examined. Results showed that pH has no significant effect on the characteristics. Alkaline precipitation is easier, however, by control of the pH. The choice between the two precipitations should be conditioned by results obtained by sintering. The work of preparing and putting into working order different desiccation methods was continued. A new desiccation cycle based on an initial period of dehydration at low temperatures indicates a more economical thermal cycle with a resulting time gain and reduction of temperature necessary for desiccation. Particles of 1.2 to 1.5 microns give the highest density. The density/time and density/temperature curves were very similar for oxides having similar surface values and O/U ratios and obtained either under dry or wet conditions, but differences in activity seem to remain. Powders having a surface area of 2 to 8 m^2/g were examined with respect to sinterability. A direct relation between surface area and density was noted under equal conditions of time and temperature. (auth)

32958 (KFK-tr-112) ADSORPTION VON YTTRIUM UND ZIRKONIUM AN ZIRKONIUMPHOSPHATEN. (Adsorption of Yttrium and Zirconium on Zirconium Phosphate). V. S. Zlobin. Translated into German by Liselotte Neander (Kernreaktor Bau- und Betriebs-Gesellschaft m.b.H., Karlsruhe, Germany) from Radiokhimiya, 4: 54-9 (1962). 12p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, as abstract no. 16390.

32959 (NP-tr-922) INFLUENCE OF THE PHYSICAL PROPERTIES OF POWDERS ON THE OPTIMUM OPERATING CONDITIONS, MIXING DEGREE AND MIXING SPEED OF SEVERAL TYPES OF MIXERS. T. Yano, I. Kanise, K. Tanaka, and S. Kurahashi. Translated by B. K. Bowes (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.) from Kagaku Kogaku, 22: 758-63 (1958). 20p.

The influences of physical properties of powders on the mixing degree and mixing speed of several types of mixers were investigated. With the same type and size of mixers, the optimum rotational speed of the mixer $N_{op}(= N_{s,o})$ and the charged volume of the powder $(F_b/V)_{op}$ were constant for all pairs of powders having the same particle size distribution. The influences of the physical properties of powders upon the mixing degree and mixing speed were found to be described by the difference of characteristic constant of both powders. As this difference increased, the values of the degree of mixing increased. (auth)

32960 (UCRL-Trans-834(L)) ELECTROCHEMICAL DETERMINATION OF DEVIATIONS FROM STOICHIOMETRY IN METAL OXIDES. H. J. Engell. Translated by Sergey Shewchuck (Univ. of California, Lawrence Radiation Lab., Berkeley) from Z. Elektrochem., 60: 905-11 (1956). 18p.

In a metal oxide of composition $Me_m \pm \gamma O_n$ the deviation from the stochiometry is designated by γ; it can be measured electrochemically. The procedure rests on the fact that during the dissolving of the oxides in an electrolytic solution the metal or metalloid excess goes into solution only in the form of ions. For the formation of these ions the addition or subtraction of electrons from the oxide is required. By placing an appropriate electrode potential of the oxide the requisite electron current flows through the outside current circuit to an opposite electrode and thereby can be measured. The ratio of the electron current to the solution current strength of the oxide corresponds to the deviation from the stochiometry. The determination of γ for FeO, CdO, and ZnO, as well as for CdO, ZnO, and CuO with foreign oxide additions is described. The limitations of this procedure and its applicability to other compounds, particularly the sulfides, are discussed. (auth)

32961 (UCRL-Trans-835(L)) USE OF THE THEORY OF SIMILARITY FOR DESCRIBING THE PROPERTIES OF LIQUIDS. L. P. Filippov. Translated by Sergey Schewchuck (Univ. of California Lawrence Radiation Lab., Berkeley) from Zhur. Fiz. Khim., 31: 582-8; 1136-9; 1999-2003; 2435-7(1957); Ibid. 32: 760-1; 986-9(1958). 57p.

The concept of similarity of substances was investigated from the position of general theory of similarity. The expediency of introducing in nondimensional relations the determining criteria of dimensionless parameters which characterize the individuality of substances is pointed out. Methods are discussed for the use of the theory of similarity applicable to the problem of describing the properties of liquids along the line of saturation. A series of practical approaches are recommended: using the relations between so-called "polydrome" criteria (dimensionless combinations which do not contain critical param-

eters); finding universal relations between values of any kind of properties at various temperatures; and deviations of critical quantities. The procedures allow the solution of problems concerning the extrapolation of the temperature dependence of various properties of liquids and the calculation of properties from other known ones. A number of applications of dimensional analysis to the description of properties of liquids are described. (M.C.G.)

32962 REVERSIBLE AND IRREVERSIBLE PROCESSES AT THE MERCURY DROP ELECTRODE. XI. Sm^{3+}, Eu^{3+}, AND Yb^{3+}. J. Almagro, V. Almagro, and J. Sancho (Facultad de Ciencias, Murcia, Spain and Instituto Rocasolano del C.S.I.C., Murcia, Spain). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 58: 203-10(Mar. 1962). (In Spanish)

A study was carried out on Sm^{3+}, Eu^{3+}, and Yb^{3+} ions in buffer solutions of 0.1M LiCl–25% ethyl alcohol, 0.1M LiCl–50% ethyl alcohol, 0.1M LiCl–75% alcohol, and 1M LiCl–50% ethyl alcohol. It was found that both Eu^{3+} and Yb^{3+} have two polarographic reduction waves, whereas Sm^{3+} has only one. The waves of these ions correspond to diffusion-ruled processes, although the second waves of Eu^{3+} and Yb^{3+} seem to move away from this characteristic. The process is irreversible in the three cases, although Sm^{3+} and Yb^{3+} approach reversibility. From the microcoulombmetric study it was concluded that Sm^{3+} is reduced with the intervention of three electrons, and it was also proved that the first wave of Yb^{3+} is reduced with the intervention of only one electron. (auth)

32963 REVERSIBLE AND IRREVERSIBLE PROCESSES AT THE MERCURY DROP ELECTRODE. XII. DERIVATIVE POLAROGRAPHY OF LANTHANIDES. V. Almagro, J. Almagro, and J. Sancho (Facultad de Ciencias, Murcia, Spain and Instituto Rocasolano del C.S.I.C., Murcia, Spain). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 58: 211-18(Mar. 1962). (In Spanish)

A study of La^{3+}, Ce^{3+}, Pr^{3+}, Sm^{3+}, Eu^{3+}, Dy^{3+}, and Yb^{3+} was carried out in buffer solutions of 0.1M LiCl, ethyl alcohol in different proportions (25, 50, and 75%), 0.5M LiCl–50% ethyl alcohol, and 1M LiCl–50% ethyl alcohol. The curves are well defined and their peak height is strictly proportional to the concentration. The study of the characteristics of these waves permits the study of the reduction mechanism, verifying, in general, the conclusions found by polarographic methods. (auth)

32964 THE THERMAL STABILITY OF THE ORGANIC COOLANT MONO-ISOPROPYL DIPHENYL. Yu. N. Aleksenko and V. A. Khramchenkov. At. Energ. (USSR), 13: 47-50(July 1962). (In Russian)

Mono-isopropyl diphenyl, prepared by alkalizing diphenyl, is considered as one of the most promising coolants and moderators for power reactors. The chemical stability while exposed to radiation of these organic compounds is of great importance and at present many experiments are being carried out to determine the maximum permissible temperature of the coolant and the rate of radiolysis at that temperature. The thermal decomposition of the material in the absence of radiation was studied. The sample was heated in a steel container, and the temperature was maintained at the desired level within ±10°C for 200 hours; a nitrogen pressure of 15 to 20 atm. was used to prevent boiling. The results indicated that the thermal decomposition starts between 340 to 370°C. At 425°C the nature of the process is changed, as indicated by the increase of the molecular weight of the high-boiling products and subsequent charring phenomena. The molecular weight of the high-boiling components formed by pyrolytic action was found to be much lower than that of the high-boiling radiolytic residue; as a result of this, the viscosity of the material changed to a much lesser extent than that of the material which underwent radiolysis and contained the same concentration of the high-boiling compound. The highest temperature at which the material can be used in a reactor was thus found to be lower than the 400°C given by D. de Halas (Second Geneva Conference for the Peaceful Uses of Atomic Energy, Geneva, 1958); this was probably due to the use of technical grade material in the study. (TTT)

32965 SOLUBILITY OF URANIUM(IV) HYDROXIDE IN HYDROFLUORIC ACID SOLUTIONS. Yu. A. Luk'yanychev and N. S. Nikolaev. At. Energ. (USSR), 13: 179-81(Aug. 1962).

The interaction of tetravalent U with F ions was investigated, using $U(OH)_4$ prepared by precipitating U(IV) sulfate with NH_4OH. The solubility of the hydroxide in HF, determined under an H_2 or N_2 blanket, is dependent on the formation of complex ions according to the equation $U^{4+} + nHF \rightleftharpoons UF_n^{4-n} + nH^+$. It was shown that the logarithm of the U fluoride is a linear function of the logarithm of the F ion concentration and the tangent of the angle of the slope of the line is numerically equal to the number of coordinate F ions. The data indicated that the value of the tangent is equal to 1, indicating the formation of the UF^{3+} ion; the concentration of this complex ion was calculated from the difference between the total U ion concentration and the concentration of the unbound U ions. The average values of the equilibrium and instability constants of UF^{3+} were found between 1.5 to 2.1×10^1 and 4.6 to 6.0×10^{-6}, respectively. The values agree well with the stability dependence of MeF^{3+} complex actinide ions on the ionic radius. (TTT)

32966 REACTION OF GRAPHITE WITH CARBON DIOXIDE AND WITH HYDROGEN. J. D. Blackwood (CSIRO, Melbourne). Australian J. Appl. Sci., 13: 199-206(Sept. 1962).

The reaction of graphite with carbon dioxide at temperatures between 650 and 870°C and at pressures between 1 and 30 atm appears to be a simpler process than that shown for more reactive low temperature chars. The rate of formation of carbon monoxide in g-mole min^{-1} g^{-1} can be expressed by Rate = $(k_1 p_{CO_2})/(1 + k_2 p_{CO})$, where k_1 and k_2 are constants and p_{CO_2} and p_{CO} are the partial pressures of carbon dioxide and carbon monoxide respectively. The rate also appears to be related to the geometric surface area and is unaffected by the pore structure. For carbons prepared at temperatures in excess of about 1500°C, the rate tends to limiting value for reaction at a given temperature and pressure and tends to become independent of the nature of the carbon. The reaction mechanism of graphite with hydrogen appears to be independent of the nature of the carbon, only the rate constants for the process being affected. (auth)

32967 SYNTHESIS OF ANHYDROUS URANYL NITRATE. B. Jeżowska-Trzebiatowska and B. Kedzia (Wrocław Technical Univ., Poland). Bull. acad. polon. sci. Ser. sci. chim., 10: 213-15(1962). (In English)

A method was developed for preparation of completely anhydrous uranyl nitrate. Anhydrous UO_3 or U_3O_8 was reacted with N_2O_4 obtained by thermal decomposition of $Pb(NO_3)_2$. The UO_3 reacted with liquid N_2O_4 quickly. The reaction required 48 to 72 hr at room temperature. The U_3O_8 reacted slowly with N_2O_4 and passed completely to $UO_2(NO_3)_2 \cdot 2NO_2$, at room temperature, after two years. (M.C.G.)

32968 MAGNETIC PROPERTIES OF α-URANIUM HYDRIDE. A. Śliwa and W. Trzebiatowski (Inst. of Physical

Chemistry, Polish Academy of Sciences, Wrocław). Bull. acad. polon. sci. Ser. sci. chim., 10: 217-19(1962). (In English)

The preparation of α-UH_3 was carried out by means of the reaction of pure uranium metal powder with pure hydrogen. X-ray analysis revealed that the product contained about 25% β-UH_3. Magentic measurements were carried out by the Faraday method at field strengths of 2750, 3970, and 6450 Oe with samples weighing about 0.01. It was found that α-UH_3 exhibits ferromagnetic properties very similar to those of β-UH_3 at low temperatures. The magnetization of the hydride sample was measured at 85°K at 5 different field intensities. The saturation magnetization was 233; the saturation moment was 0.9 $\mu\beta$. (M.C.G.)

32969 MOLECULAR SPECTROSCOPY OF ANHYDROUS URANYL SALTS. I. ABSORPTION SPECTRA OF ANHYDROUS URANYL NITRATE IN SOME ORGANIC SOLVENTS. B. Jeżowska-Trzebiatowska and B. Kedzia (Wrocław Technical Univ., Poland). Bull. acad. polon. sci. Ser. sci. chim., 10: 275-81(1962). (In English)

The spectra of anhydrous uranyl nitrate in organic solvents were investigated in the range from 360 to 500 mμ. The spectra retained their vibrational character in all investigated solvents and do not differ markedly from those of the sesquihydrate and other hydrates. The appearance of 10 absorption bands in the range 20,000 to 28,000 cm^{-1} was established. Vibrations were distinct in the long wave range. In the short-wave range a marked diffusion of absorption bands was observed. (M.C.G.)

32970 MOLECULAR SPECTROSCOPY OF ANHYDROUS URANYL SALTS. II. FORCE CONSTANTS. INTERATOMIC BOND LENGTH, DISSOCIATION ENERGY AND OSCILLATOR STRENGTHS OF URANYL. B. Jeżowska-Trzebiatowska and B. Kedzia (Technical Univ., Wrocław, Poland). Bull. acad. polon. sci. Ser. sci., chim., 10: 283-6(1962). (In English)

Analysis of spectra of uranyl nitrate in organic solvents permitted estimation of the vibration quantum as the mean frequency difference in particular bands. Force constants for the UO_2^{2+} ion were calculated. The U–O distances were also calculated. Formulas are given for oscillator strengths in particular spectra of anhydrous uranyl nitrate. Dissociation energy of the uranyl ion was also calculated. (M.C.G.)

32971 A PROPOSED STRUCTURE FOR ANNEALED ANODIC OXIDE FILMS OF TANTALUM. L. D. Calvert and P. H. G. Draper (National Research Council, Ottawa). Can. J. Chem., 40: 1943-50(Oct. 1962). (NRC-6931)

Anodic oxide films (~1500 Å thick) formed on tantalum in saturated H_3BO_3, saturated Na_2SO_4, 86% H_3PO_4, 1% H_2SO_4, and 100% H_2SO_4 were examined by a simple but sensitive glancing angle x-ray technique. They are amorphous as formed but can be crystallized on annealing at various temperatures between 500 and 1000°C. The times and temperatures required for crystallization depend on the electrolyte used. The crystallization process is competitive with the dissolution of oxygen in the substrate metal. The observed powder diffraction patterns show considerable variation from sample to sample. Similar variations have been reported in the literature for different samples of Ta_2O_5. A structural model is proposed for β-Ta_2O_5 based on the isostructural relationship with U_2O_5, whose structure is related to that of α-UO_3. This proposed structure consists of linear chains of Ta–O–Ta–O– parallel to the c axis with varying disorder in the ab plane. This disorder accounts for the observed variations in the patterns. The proposed structure is a defective one and the ordering of these defects may account for some of the reports of irreversible transformations observed on heating Ta_2O_5. (auth)

32972 THE MASS SPECTRA OF THREE DEUTERATED BROMOBUTANES. W. H. McFadden and M. Lounsbury (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem., 40: 1965-75(Oct. 1962). (AECL-1586)

The mass spectra of 1,1-dideutero-1-bromobutane, 1,1,1,3,3-pentadeutero-2-bromobutane, and 1,1,1,2,3,3-hexadeutero-2-bromobutane were obtained using 70-volt ionizing electrons. The cracking patterns of the deuterated molecules are compared with those of the undeuterated bromobutanes. It is shown that no hydrogen-deuterium exchange occurs in certain ions formed from the parent ion by simple bond break but that extensive exchange of hydrogen and deuterium occurs in ions formed by further decomposition of unsaturated daughter ions. Formation of HBr^+ or loss of HBr to form $C_4H_8^+$ from 2-bromobutane is shown to favor sterically the hydrogen on carbon 4 and not to involve that on carbon 2. However, in the case of 1-bromobutane, formation of these ions does not appear to involve any particular hydrogen preferentially, because if one assumes that all hydrogens in the molecule are involved, then the hydrogen on carbon 1 appears to be involved to an almost statistical extent. In two cases the isotopic substitution so modifies the rate of a metastable reaction that the metastable peak disappears from the spectra of the deuterated species. (auth)

32973 CARBON-13 KINETIC ISOTOPE EFFECTS IN BIMOLECULAR REACTIONS. J. B. Stothers and A. N. Bourns (McMaster Univ., Hamilton, Ont.). Can. J. Chem., 40: 2007-11(Oct. 1962).

Carbon-13 kinetic isotope effects were measured for the bimolecular reaction of 1-phenyl-1-bromoethane (I) and benzyl bromide (II) with alkoxide ion in alcohol solution. Compound I gave an effect, k^{12}/k^{13}, of 1.0032 ± 0.0005 for reaction with ethoxide ion in ethanol, while II gave k^{12}/k^{13} = 1.0531 ± 0.0004 for reaction with methoxide ion in methanol. These surprisingly different effects are tentatively interpreted in terms of a model for the transition state having varying degrees of ionic character. (auth)

32974 KINETICS OF OXIDATION OF COLUMBIUM AND OTHER REFRACTORY METALS. J. N. Ong, Jr. and W. M. Fassell, Jr. (Ford Motor Co., Newport Beach, Calif.). Corrosion, 18: 382t-9t(Oct. 1962).

The oxidation of tungsten and molybdenum occurs by two consecutive reactions, forming first a suboxide then the trioxide. Tantalum and niobium oxidize by four simultaneous reactions: solution of oxygen in the metal, nucleation and growth of a suboxide phase at the metal surface, and two phase boundary processes giving rise to two different modifications of the pentoxide. By assuming that all reactions are first order complex chain reactions, rate equations are formulated giving the rate of oxidation as a function of pressure, temperature, and time. Regression rate expressions for the metals tungsten, tantalum, and niobium above 700°C are given as $(dx_w/dt) = 3.05 \times 10^2 \times 10^{-3230/T} P_{O_2}^{1/2}$; $(dx_{Ta}/dt) = 33.2 \times 10^{-4801/T} P_{O_2}^{1/2}$; and $(dx_{Cb}/dt) = 1.19 \times 10^{-3440/T} P_{O_2}^{1/2}$, respectively. The rate is expressed in cm/hr, T is in degrees K, and P_{O_2} in atmospheres pressure of oxygen. (auth)

32975 FLAME SPECTROSCOPY OF THE RARE EARTH ELEMENTS. Ronald Howard Curry (Iowa State Univ. of Science and Tech., Ames). Dissertation Abstr., 23: 413-14(Aug. 1962).

It was found that by using a fuel-rich oxygen-acetylene flame of a Beckman integral aspirator-burner and absolute ethanol as the solvent all of the rare earths except cerium

emit moderate to strong atomic lines. The exact wavelengths of over 1200 of these lines were measured and their relative intensities estimated. Using these lines, analytical methods were developed for the determination of Dy, Ho, Er, Tm, Lu, and Sc in complex mixtures of rare earths. The detection limits and possible interferences were assessed for the strong lines of each element. The data indicate that only lanthanum, cerium, and perhaps gadolinium cannot be determined by this method. The degree of enhancement of the atomic lines in the fuel-rich oxygen-acetylene flame varies with each element, ranging from a factor of 3.4 for europium up to greater than 6000 for neodymium. The greatest enhancements were observed for those elements which form the most stable monoxides. Effective electronic temperature measurements using atomic iron lines indicate that the oxygen-acetylene flame which produces maximum rare earth line emission is operating at a temperature of 3050°K. Electronic equilibrium appeared to be established in this flame. The maximum temperature attained with the oxygen-acetylene flame was 3185°K. The flame produced line emission significantly lower in intensity than the more fuel-rich flame. An effective electronic temperature of 2900°K was found for the oxygen-hydrogen flame.

32976 A LIGHT SCATTERING INVESTIGATION OF THE AGGREGATION IN AQUEOUS SOLUTIONS OF ZIRCONYL CHLORIDE AND ISOPIESTIC STUDIES ON AQUEOUS SOLUTIONS OF SOME HETEROPOLY ACIDS. Richard Lee Angstadt (Univ. of North Carolina, Chapel Hill). Dissertation Abstr., 23: 424-5(Aug. 1962).

Light scattering of the polymerization of zirconyl chloride in acid solutions and isopiestic studies on aqueous solutions of some heteropoly acids are described. Two series of zirconyl chloride solutions were studied. In one series the total acid concentration was held constant at $[H^+] = 2.800$ M, and the gegenion concentration was held constant at $[Cl^-] = 3.000$ M. In another series both the total acid and gegenion concentrations were again held constant: $[H^+] = 0.750$ M, $[Cl^-] = 1.000$ M. Refractive indexes and turbidities were measured. The data lead to the conclusion that in 2.800 M HCl the predominate species is a trimer with a charge of about plus 3, $[Zr(OH)_2]_3Cl_3^{3+}$. In 0.750 M HCl the predominate species appears to be a hexamer with a charge of between 5 and 6, $[Zr(OH)_2]_6Cl_6^{6+}$ or $[Zr(OH)_2]_6Cl_5^{5+}$. The isopiestic investigation involved solutions of the heteropoly acids, 9-tungstophosphoric and 12-tungstosilicic. The solvent activities of such solutions both with and without added electrolyte are tabulated. In the absence of any added electrolyte it was possible to calculate turbidities in good agreement with those actually measured. Activity coefficients were calculated for aqueous solutions of 12-tungstosilicic acid.

32977 SOME PROPERTIES OF RARE EARTH-NITRILOTRIACETATE COMPLEXES. Samuel Charles Levy (Iowa State Univ. of Science and Tech., Ames). Dissertation Abstr., 23: 428(Aug. 1962).

The stability constants of the 1:1 and 1:2 rare earth-nitrilotriacetate complexes were measured polarographically at 10, 20, 30, and 40°C at an ionic strength of 0.10. The stability constants of the 1:1 complexes increased with increasing atomic number of the rare earth through samarium, decreased at europium and gandolinium, and then increased linearly through lutetium. The stability of the 1:2 rare earth-NTA complexes increased from lanthanum through terbium, decreased from dysprosium through thulium, and showed a slight increase at ytterbium and lutetium. The stability of the yttrium chelate was nearest that of the terbium chelate in the 1:1 complex and closest to the samarium chelate in the 1:2 complex. The so-called gadolinium break was evident in both series of constants. The measured constants correctly predicted the extent of separation of the entire rare earth series and also the position of yttrium in the ion-exchange separation of the rare earths using NTA as eluant. The thermodynamic functions $\Delta F°$, $\Delta H°$, and $\Delta S°$ were calculated for both sets of compounds from the temperature dependence of the stability constants. A positive enthalpy change was found for the series of 1:1 complexes and a negative enthalpy change for the series of 1:2 complexes. In both series of compounds, it was found that the main driving force for chelation was a favorable entropy change. The solid 1:1 rare earth-NTA chelates were prepared at different temperatures and analyzed. The hydrates found for the various species ranged from mono to pentahydrates. There seemed to be no order in the lightest members of the series, where almost every hydrate was found. The middle members of the series formed only the trihydrate and the heavier members each formed a dihydrate and a tetrahydrate. The solubility of each hydrate of the 1:1 rare earth-NTA chelates was measured at 25 and 60°C.

32978 PART I. COORDINATION CHAIN REACTIONS. PART II. ZIRCONIUM COMPLEXES OF NITRILODIACETATE DERIVATIVES OF THE SULFONPHTHALEINS. Donald Craig Olson (Purdue Univ., Lafayette, Ind.). Dissertation Abstr., 23: 429-30(Aug. 1962).

I. The kinetics of the ligand exchange reaction between triethylenetetramine-nickel(II) (NiT^{2+}) and ethylenediaminetetraacetato-cuprate(II) (CuY^{2-}), were studied under a variety of conditions. The reaction $NiT^{2+} + CuY^{2-} \rightarrow CuT^{2+} + NiY^{2-}$ orders with respect to NiT^{2+} and CuY^{2-} revealed a rate law which is complex and varies with both relative conditions and pH. A chain mechanism is proposed for the exchange which is consistent with the observed reaction orders. The rapid multidentate substitution reactions which act as chain propagating steps permit the exchange to occur at a rate much greater than either NiT^{2+} or CuY^{2-} can dissociate independently. The mechanism is supported by the catalytic effect of very low concentrations of trien or EDTA on the rate and by the inhibition of the rate by low concentration of metal ions. The application of coordination chain reactions to the determination of trace metals and ligands was demonstrated. II. The commercially obtained metallochromic indicator, xylenol orange, 3,3′-bis(N,N-di(carboxymethyl)-aminomethyl-o-cresolphthalein was found to be impure and could be separated into three major components both on a cellulose column and by recrystallization from ethanol and butanol. Two of these were identified as xylenol orange and the mono-substituted product, 3-N,N(carboxymethyl)-aminomethyl-o-cresolsulfonphthalein, which is given the name semi-xylenol orange. Semi-xylenol orange was found to add a proton to the keto group in strong perchloric acid. The apparent ionization constant of the protonated form was determined at 25.0°C and $\mu = 2.0$. The compound forms two complexes with Zr(IV), a 1:1 complex in 2.05 M perchloric acid, and a 1:2 complex, ligand to metal, in 1.02 M perchloric acid. Methylthymol blue, 3,3′-bis(N,N-di(carboxymethyl)-aminomethyl thymolsulfonphthalein, also formed a 1:2 complex with Zr(IV) in 1.02 M perchloric acid. The data indicate the presence of a polymeric species of Zr(IV) present in 1.02 M perchloric acid which is not present in 2.05 M perchloric acid. The molar absorptivity of the complex formed with Zr(IV) when semi-xylenol orange is in large excess in the (H^+) of 0.20 to 1.0 was found to be 59000. The high molar absorptivity of the complex makes sem.-xylenol

orange a sensitive colorimetric reagent for the determination of zirconium.

32979 VIBRATION-ROTATION INTERACTIONS IN INFRARED ACTIVE OVERTONE LEVELS OF SPHERICAL TOP MOLECULES; $2\nu_3$ AND $2\nu_4$ OF CH_4, $2\nu_3$ OF CD_4. Kenneth Fox (Univ. of Michigan, Ann Arbor). Dissertation Abstr., 23: 656(Aug. 1962).

A theoretical account of the infrared spectra of methane is given. The symmetry of the tetrahedral XY_4 molecule leads to the use of the formalism of irreducible spherical tensors and the modern formulations of angular momentum coupling in the treatment of vibration-rotation interactions arising in the calculation of the energy levels and relative line intensities. In the conventional representation (R1), theory predicts five P, Q, and R branches of roughly comparable intensity for the first overtones provided that the vibrational angular momentum quantum number $\underline{l}$ is approximately a good quantum number for the complete vibration-rotation Hamiltonian. In this case, the separation of the E and F_2 vibrational components of the $\underline{l} = 2$ vibrational state must be small compared with the splittings which arise from the $2B\zeta$ $(P \cdot \underline{l})$ term. The band $2\nu_4$ of CH_4 is shown to be consistent with this approximation. The theory is extended to predict an overtone spectrum with a single strong P, Q, and R branch structure. Transitions to the levels associated with the E vibrational substate are extremely weak, and the P, Q, and R lines associated with the F_2 vibrational substate are similar to those of the fundamental. The bands $2\nu_3$ of both CH_4 and CD_4 are shown to be accounted for by this approximation. The tetrahedral splittings in the vibration-rotation levels of $2\nu_3$ of CD_4 are appreciable, and are accounted for very well by constants, which give the splittings throughout the spectrum. Linear combinations of effective rotational constants obtained from the spectrum are given. The spectrum of $2\nu_4$ of CH_4 is extremely complex as a result of the tetrahedral splittings and the overlapping of the five P, Q, and R branches. Definite assignments for the observed lines were not made.

32980 A NEUTRON DIFFRACTION STUDY OF NICKELOUS OXIDE. David Owen Murray (Ohio State Univ., Columbus). Dissertation Abstr., 23: 668-9(Aug. 1962).

Measurements of the magnetic form factor of the Ni^{2+} ion in antiferromagnetic NiO are reported and the significance of the results is discussed. A neutron diffractometer apparatus is also described. Techniques for growing the large single crystals of lead used for producing monochromatic neutron beams are described, and the characteristics of the neutron beams resulting with various crystals in reflection and transmission are reported. To obtain the angular dependence of the absolute magnetic scattering it was necessary to include several important corrections to the observed scattered intensities. Correcting for the effects of absorption-extinction and lattice thermal vibrations was accomplished by computational methods. A study of the anomalous intensity in certain magnetic reflections is reported. Such anomalies are attributed to Bragg double-reflections, and a computer program for identifying all possible interference reflections for a given crystal orientation is discussed. The observed magnetic form factor for Ni^{2+} clearly showed the e_g symmetry expected for a magnetic $3d^8$ electron distribution which is placed in the crystalline field of six octahedrally coordinated O^{2-} ions. The absolute magnitude of the forward magnetic scattering indicated that with $g = 2.225$, the effective spin value of the nickelous ion is 0.75 instead of unity, and that the fall-off of the form factor at large scattering angles is less rapid than shown by the calculations. Several possible mechanisms to account for these discrepancies are discussed, and the most satisfactory explanation is given by assuming a partially covalent bond for Ni^{2+} and O^{2-}.

32981 SPECIFIC HEAT OF He^3. Gerhard Ludwig Salinger (Univ. of Illinois, Urbana). Dissertation Abstr., 23: 669(Aug. 1962).

The heat capacity of a mixture of He^3 and powdered cerium magnesium nitrate was measured from 0.02°K to temperatures as high as 0.1°K at pressures of 0.12, 1.1, 3.4, 6.1, 11.8, 21.1, 28.0 atm and for pressures greater than the minimum of the melting pressure curve, P_{min}, at external pressures of 30.7, 32.8, and 34.8 atm. The specific heat of He^3 seems to be linear in T below temperatures of 0.03°K only at the lowest pressures, but at higher pressures it is possible that the linear temperature dependence of the specific heat, characteristic of a Fermi liquid, has not been developed by 0.02°K. Assuming a Fermi liquid behavior below 0.03°K, a ratio of specific heat to temperature of 2.78 $R°K^{-1} \pm 10\%$ corresponding to a ratio of the effective mass of the quasi-particle to the mass of the He^3 atom of 2.82 ±10% was obtained at zero pressure. Below 25 atm, the pressure dependence of the slope of the best straight line through the specific heat data near 0.03°K and the origin was used to deduce a lower limit, $-0.08°K^{-2}$, for the value of the temperature derivative of the isobaric expansion coefficient. No discontinuity in the specific heat was found down to 0.02°K for the full pressure range in the liquid, indicating an absence of a cooperative transition. The thermal boundary resistance between He^3 and the chrome alum refrigerator was measured in a more restricted temperature range than the specific heat, and was found to decrease as pressure increased. The thermal boundary resistance between He^3 and the walls of its container was estimated. A computation was made to determine the theoretical pressure dependence of the boundary resistance. At pressures above P_{min} and at low temperatures, the liquid phase of He^3 had a smaller specific heat and a reduced thermal boundary resistance relative to that at somewhat lower pressures, indicating a possible new phase of He^3. The measurements on solid He^3 revealed a small specific heat increasing as temperature decreased below 0.036°K, indicating a very small exchange interaction in solid He^3.

32982 THE INFRARED ABSORPTION SPECTRA OF TITANIUM AND NIOBIUM OXALATES. L. G. Vlasov, B. V. Lapitskii, and M. A. Salimov (Moscow Univ.). Dokl. Akad. Nauk SSSR, 145: 1055-7(Aug. 11, 1962). (In Russian)

The number of absorption bands in the infrared region increases on going from simple oxalates to more complex oxalates. Thus, in the region between 1100 and 1600 cm^{-1}, three bands are observed for complex oxalates and only two bands for simple oxalates, and in the region between 750 and 900 cm^{-1}, two bands instead of one. Infrared spectra were run on the following compounds: $Na_3[NbO(C_2O_4)_3] \cdot 2H_2O$, $K_3[NbO(C_2O_4)_3 \cdot 2H_2O$, $(NH_4)_3[NbO(C_2O_4)_3] \cdot 2H_2O$, $Ca[TiO(C_2O_4)_2] \cdot 4H_2O$, $Sr[TiO(C_2O_4)_2] \cdot 5.5\ H_2O$ and $Ba[TiO(C_2O_4)_2] \cdot 4H_2O$. At the same time, infrared spectra were taken of the simple sodium, potassium, ammonium, calcium, strontium, and barium oxalates for purposes of comparison. The salts containing titanium or niobium showed two absorption bands in the 750 to 900 cm^{-1} region, and three absorption bands in the 1100 to 1600 cm^{-1} region. These compounds can be considered as complex oxalates. The simple oxalates showed one absorption band less in these regions of the infrared spectrum. All the niobium derivates contain an intensive band at 1720 cm^{-1}, which is ascribed to an undissociated carboxylic group, and a band near 1620 cm^{-1},

which belongs to a dissociated carboxylic group. In the niobium complexes, two oxalate groups decompose at 200 to 220°C, and the third oxalate group decomposes only at 320 to 350°C. Both oxalate groups in the titanium derivates decompose at the same time. The following general formulas are proposed for the titanium and niobium compounds: $Me^{II}[TiO(C_2O_4)_2 \cdot nH_2O$ and $Me^{I}[NbO_2C_2O_4] \cdot 2Me^{I}HC_2O_4 \cdot mH_2O$. Here Me^{II} is a divalent metal and Me^{I} is a monovalent metal. (TTT).

32983 AN INVESTIGATION OF THE VAPOR DENSITY OF HAFNIUM TETRACHLORIDE AT HIGH TEMPERATURES. V. I. Tsirel'nikov, L. N. Komissarova, and Vikt. I. Spitsyn (Moscow Univ.). Dokl. Akad. Nauk SSSR, 145: 1081-4(Aug. 11, 1962). (In Russian)

Hafnium tetrachloride, tagged with Hf^{181}, was prepared with a specific activity of 50 mc/g by chlorinating metallic hafnium previously irradiated with slow neutrons in a reactor. The $HfCl_4$ was further purified by a double vacuum distillation in a current of hydrogen. In order to measure the vapor density of $HfCl_4$, two furnaces were set up perpendicular to each other, and two quartz ampoules connected by a heated capillary (~1mm^2 in cross-section) were mounted in the two furnaces. The tagged $HfCl_4$ was sublimed into the ampoule. The temperature of either furnace could be varied independently from 390 to 1000°C. The unit was calibrated by taking radiation readings on an electrometer, and then determining the amount of $HfCl_4$ present in the ampoule by the usual gravimetric methods. The vapor density of $HfCl_4$ could be calculated from the weight of $HfCl_4$, the volume of the vessel, and the calibrated radiation reading. The vapor density of $HfCl_4$ is given as a function of temperature from 390 to 1000°C at a constant pressure of 0.5, 1.0, and 1.5 atmospheres. The vapor density of $HfCl_4$ is also given as a function of pressure from 100 to 1240 mm Hg std. at a constant temperature of 398, 467, and 865°C. At high temperatures and low pressure, the $HfCl_4$ vapor is ideal in behavior. On raising the pressure above atmospheric pressure, and decreasing the temperature close to the sublimation temperature, the actual vapor density of $HfCl_4$ is about 10% below that of an ideal gas. (TTT).

32984 APPLYING THE DIALYSIS METHOD TO THE STUDY OF THE STATE OF NIOBIUM AND TANTALUM IN SOLUTION. A. K. Babko and G. I. Gridchina (Inst. of General and Inorganic Physics, Academy of Sciences, Ukrainian SSR). Dopovidi Akad. Nauk Ukr. RSR, No. 7, 921-4 (1962). (In Ukrainian)

The method of comparative dialysis was used to study the state of niobium and tantalum in aqueous solutions, Co^{2+} for acid solutions and CrO_4^{2-} for alkaline solutions being used as comparison ions. On the basis of the calculated values of the relative dialysis coefficients, it was established that monomeric niobium ions exist only in 11-10 N HCl; polyons begin to form below 10 N HCl. Tantalum under the same conditions is in the form of polymeric particles. The various degrees of polymerization permit the separation of niobium from tantalum. In alkaline solutions at a concentration of $(Na(Ta)) = 2.5 \times 10^{-3}$ mole/l there exist only polymeric ions of niobium and tantalum, the size of which increase with a decrease in alkali concentration from 1 to 0.01 N. The polymeric forms of niobium and tantalum, formed in an acid medium, are much more stable than those formed in an alkaline medium. In the presence of six grams of fluorine per gram of niobium and of 20 grams of fluorine per gram of tantalum in 1-0.1 N HCl, complete depolymerization takes place. (auth)

32985 REACTIONS OF METAL-AMMONIA SOLUTIONS. III. KINETICS, ISOTOPIC EXCHANGE AND FRACTIONATION IN THE REACTIONS OF SODIUM AND ETHANOL IN TRITIATED AMMONIA. Eugene J. Kelly, Henry V. Secor, Charles W. Keenan, and Jerome F. Eastham (Univ. of Tennessee, Knoxville). J. Am. Chem. Soc., 84: 3611-18 (Oct. 5, 1962).

Detailed techniques and apparatus are described for forming solutions of metals and other reactants in ammonia labeled with tritium, quantitatively collecting gas evolved from these solutions, and radioassaying this evolved gas. When a proton donor (ethanol) is mixed with a metal (sodium) in tritiated ammonia, five reactions which may occur involve isotopic exchange between solvent and proton donor and attack of electrons on each to liberate hydrogen or tritium. With the experimental data collected and mathematical expressions derived, it is shown that exchange of tritium between ammonia and ethanol as a proton donor is instantaneously fast relative to attack of electrons on the alcohol, and that isotopic fractionation, i.e., relative rates of hydrogen and of tritium liberation, changes as the liberation reaction proceeds. The interpretation of this change in fractionation, that it is a consequence of a change in the nature of the alcohol, is consistent with the finding that the kinetic order of the hydrogen liberation changes after 25% reaction of the donor. This reaction begins by a process (initial 25% of reaction) whose rate is first order in alcohol but independent of the metal concentration, and then becomes a process which is first order in each reactant. Rate constants of these processes are determined and the mechanism of the hydrogen liberation reaction discussed. (auth)

32986 HIGH-RESOLUTION FLUORINE MAGNETIC RESONANCE SPECTRA OF SOME PERFLUOROALKYL DERIVATIVES OF SULFUR HEXAFLUORIDE. Max T. Rogers and John D. Graham (Michigan State Univ., East Lansing). J. Am. Chem. Soc., 84: 3666-70(Oct. 5, 1962).

The high-resolution fluorine magnetic resonance spectra of a group of perfluoroalkyl derivatives of sulfur hexafluoride were analyzed and the chemical shifts and spin-spin coupling constants determined. The fluorine chemical shifts are found to vary with the electronegativity of the substituents. Fluorine-fluorine coupling constants are observed between nuclei separated by three, four, and five bonds, but the coupling constants do not vary in a coherent manner with a change in the number of bonds separating interacting nuclei. The results are in agreement with the idea that coupling between fluorine nuclei separated by three or four single bonds is due to both through-space and through-bond interactions but that the importance of the through-bond interaction falls off rapidly with the number of intervening bonds and the coupling is largely a through-space interaction when the nuclei are separated by five single bonds. The very small coupling constants observed for interaction between nuclei separated by three bonds in the CF_3-CF_2 and $-CF_2-CF_2-$ fragments would still appear to be anomalies possibly to be explained as resulting from rotational averaging of trans and gauche coupling constants of opposite signs. (auth)

32987 MATRIX REPRESENTATION OF THERMODYNAMIC PROPERTIES OF MULTICOMPONENT SYSTEMS. Robert R. V. Wiederkehr (Dow Chemical Co., Midland, Mich.). J. Chem. Phys., 37: 1192-9(Sept. 15, 1962).

Thermodynamic properties of multicomponent systems can be simply generated from matrices whose elements represent basic data. Although this concept is quite general, it was applied specifically to generating the entropy, enthalpy, and free energy of multicomponent systems, as functions of composition and temperature. Each of these properties can be generated from the product of three ma-

trices: a row vector whose elements depend only on the composition, a rectangular matrix whose elements remain invariant for a given system, and a column vector whose elements depend only on the temperature. A given row of the rectangular matrix corresponds to one of the species in the system and may be regarded as a thermodynamic-property vector for that species. Thermodynamic-property vectors were calculated and tabulated for 143 species which are stable at high temperatures. The matrix representation of thermodynamic data proved to be particularly useful in formulating large multicomponent problems for a digital computer. Two numerical examples illustrate the utility of the method. (auth)

32988 TEMPERATURE DEPENDENCE OF THE ESR SPECTRUM OF IRRADIATED ORIENTED POLYETHYLENE. Shun-Ichi Ohnishi, Shun-Ichi Sugimoto, and Isamu Nitta (Japanese Assn. for Radiation Research on Polymers, Neyagawa City, Osaka). J. Chem. Phys., 37: 1283-8 (Sept. 15, 1962).

Temperature dependence of the ESR spectrum in irradiated polyethylene was studied using stretched specimens. Among the observed spectra the septet spectrum with doublet substructure is known to be due to an "allyl type" $-CH_2-\dot{C}H-CH=CH-CH_2-$ radical. Although the spectrum observed at 142°C is such a septet (splitting 21.3 G) with doublet substructure (splitting 5.5 G), it changes with temperature in a complicated way. Positions of the peaks are displaced, and their apparent number changes, while the spectrum below −180°C remains unchanged. Such changes were found completely reversible with temperature, and the magnitude of the over-all splitting as well as the outermost doublet remained constant. The analysis of this complicated temperature dependence was carried out on the assumption that the hyperfine coupling constant of the β protons changes with temperature, while that of the α protons remains constant. By choosing an appropriate set of coupling constants (A_β) of β protons, the observed spectrum could be reproduced. From the spectrum at −180°C were deduced $A_{\beta_1} = 30$ G and $A_{\beta_2} = 11$ G. Such inequivalence of the coupling might suggest that the methylenic group in the "allyl type" radical should be twisted with respect to the nodal plane of the unpaired π electron. As the temperature rises, a hindered oscillation of the methylenic group will take place between two equivalent twisted positions with respect to the same nodal plane. Such behaviors were interpreted using a theory of time-dependent phenomena and the activation energy was obtained to be 410 cal/mole, the frequency factor being 4.6×10^8 sec^{-1}. (auth)

32989 MECHANISM OF BENZIDINE AND SEMIDINE REARRANGEMENTS. PART IX. SUBSTRATE-ISOTOPE EFFECTS ON KINETICS AND PRODUCTS OF ACID REARRANGEMENT OF 1,1′-HYDRAZONAPHTHALENE. D. V. Banthorpe, E. D. Hughes, Christopher Ingold, and R. Humberlin (University Coll., London). J. Chem. Soc.: 3299-3308 (Sept. 1962).

1,1′-Hydrazonaphthalene, as well as its 2,2′- and 4,4′-dideutero-derivatives, the preparation of which is described, were rearranged with acid in "60%" aqueous dioxan, and comparisons were made of rearrangement rates and product proportions. The same hydrazo-compounds were rearranged with acid in 95% aqueous ether–ethanol, and comparisons were made of product proportions. In the conditions of these comparisons, three products alone are formed, the single 4,4′-ring-coupled product, naphthidine, and the pair of 2,2′-ring-coupled products, dinaphthyline, and its cyclised relative, dibenzocarbazole, all in substantial, easily measurable, amounts. In the dioxan solvent, neither 2-deuteration nor 4-deuteration affects the overall rate of rearrangement. In both solvents, neither 2- nor 4-deuteration affects the ratio of 4,4′- to total 2,2′-ring-coupled products. In both solvents, 2-deuteration, but not 4-deuteration, does change the internal ratio of the two 2,2′-ring-coupled products, the shift being large, and in favor of the carbazole. Conclusions are drawn concerning the activation of the aromatic proton losses, and their disposition among the product-forming steps of rearrangement. (auth)

32990 MECHANISM OF BENZIDINE AND SEMIDINE REARRANGEMENTS. PART X. SUBSTRATE-ISOTOPE EFFECTS ON KINETICS AND PRODUCTS OF ACID REARRANGEMENT OF THE HYDRAZOBENZENES. D. V. Banthorpe and E. D. Hughes (University Coll., London). J. Chem. Soc.: 3308-13 (Sept. 1962).

Hydrazobenzene, its 4,4′-dideutero-derivatives, and a derivative C-deuterated everywhere except in 4,4′-positions, were rearranged with acid in aqueous dioxan and in aqueous and anhydrous ethanol; and comparisons were made of the rearrangement rates and product proportions. The products are benzidine 76 to 72%, and diphenyline 24 to 28%, the small variation depending on the solvent. Neither in para- nor in ortho-positions does deuteration make a detectable difference either to reaction rates or to product ratios. The aromatic proton losses are concluded to occur after the activation barrier for rearrangement has been surmounted, and after the mechanism has decisively branched towards the individual products. (auth)

32991 MECHANISM OF BENZIDINE AND SEMIDINE REARRANGEMENTS. PART XI. NOTES ON TWO TYPES OF DIAZO-REDUCTION. D. V. Banthorpe and E. D. Hughes (University Coll., London). J. Chem. Soc.: 3314-18 (Sept. 1962).

When the 1-nitronaphthalene-2-diazonium ion is reduced with protium-free D_3PO_2 in the presence of D_2SO_4 in dioxan, with exclusion of atmospheric moisture, most of the diazo-group is replaced by protium. This protium is derived from the dioxan, in which it becomes replaced by deuterium. A similar effect on deuteration through Grignard reagents and D_2O in ether is recalled, and an explanation is advanced which relates both effects to the autoxidation of ethers. When naphthalene-1-diazonium ions containing deuterium in known positions are converted by reductive coupling with buffered sulphite into 1,1′-azonaphthalenes, the original orientations of deuterium relative to nitrogen are preserved in both aryl groups of the azo-derivative. The deuterium orientations were determined in the corresponding hydrazo-compounds, by rearranging them with acid, separating the products, and comparing the deuterium contents of the factors and separated products. The results delimit possible views of the mechanism of the reductive coupling. It is shown or confirmed that the various deuterated hydrazo-compounds, the preparation and reactions of which are described in Parts IX and X, have the constitutions there assigned to them. (auth)

32992 HYDROGEN ISOTOPE EFFECTS IN THE EQUILIBRIA BETWEEN 2,4-DINITROPHENOL AND AMINES. R. P. Bell and J. E. Crooks (Oxford Univ.). J. Chem. Soc.: 3513-16 (Sept. 1962).

Spectrophotometric measurements show that in toluene solution triethylamine forms only hydrogen-bonded complexes with m-nitrophenol, p-nitrophenol, pentachlorophenol, and 2-bromo-5-nitrophenol, while proton transfer to give ion pairs takes place with o-nitrophenol and with 2,4-, 2,5-, and 2,6-dinitrophenol. The deuterium isotope effect was studied in toluene or chlorobenzene solution for the equilibria of 2,4-dinitrophenol with triethylamine, piperi-

dine, pyridine, and N,N-dimethylaniline. There is no detectable effect with triethylamine and piperidine, but with pyridine $K_H/K_D = 1.40 \pm 0.05$; N,N-dimethylaniline probably occupies an intermediate position. The results can be accounted for quantitatively in terms of observed spectral frequencies and the occurrence of hydrogen bonding in the ion-pairs formed from weak bases. (auth)

32993 HYDROLYSIS PROPERTIES OF URANIUM MONOCARBIDE AND DICARBIDE. C. P. Kempter (Los Alamos Scientific Lab., N. Mex.). J. Less-Common Metals, 4: 419-25(Oct. 1962). (TID-15185). (In English)

The hydrolysis of commercial UC and UC_2 prepared by arc melting uranium metal and spectro grade graphite was investigated. A quantitative mass spectrographic study of the room temperature gaseous hydrolysis products showed UC to produce mainly methane and UC_2 to produce mainly ethane and other alkanes. The UC gaseous hydrolysis products are very similar to those produced by ThC and PuC. The UC_2 products are similar to those produced by ThC_2 in that both consist of about two-thirds even-numbered carbon atom hydrocarbons, about three-tenths hydrogen plus methane, and a small fraction of catenated odd-numbered carbon atom hydrocarbons. (auth)

32994 OXIDATION OF URANIUM MONOCARBIDE. K. A. Peakall and J. E. Antill (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Less-Common Metals, 4: 426-35(Oct. 1962). (AERE-R-3844). (In English)

Compacts of uranium monocarbide with a density of 11.7–12.7 g/cm^3 were oxidized in 1 atm of CO_2, O_2, N_2, and CO at temperatures in the range 350 to 1000°C and all the reactions found to obey a linear rate law. The linear rate constants increased as the temperature increased and the density decreased, and for dense compacts were normally similar to or less than the corresponding values for uranium metal, the notable exception being for CO_2 at 500 to 700°C. (auth)

32995 THE PREPARATION AND PROPERTIES OF A HYDROUS RUTHENIUM OXIDE. C. J. Keattch (International Nickel Co. (Mond.) Ltd., London) and J. P. Redfern. J. Less-Common Metals, 4: 460-5(Oct. 1962). (In English)

The preparation of a hydrous ruthenium oxide is described to which the empirical formula RuO_2H_2O is assigned. Its thermogravimetric behavior has been studied. The kinetics of the decomposition were evaluated for the reaction: $RuO_2H_2O \rightarrow RuO_2 + H_2O$. The hydrous material and the anhydrous oxide (below 1,100°C) show catalytic properties. Some preliminary infra-red and x-ray studies yielded little positive information. (auth)

32996 COMPLEXES OF NIOBIUM AND TANTALUM HYDROXIDES WITH DI-OLS. F. Fairbrother, N. Ahmed, K. Edgar, and A. Thompson (Univ. of Manchester, Eng.). J. Less-Common Metals, 4: 466-75(Oct. 1962). (In English)

The dissolution of niobium and tantalum hydroxides in alkaline solutions of catechol and other 1-2, di-ols was studied and solid crystalline products isolated. These show some variability in composition consequent upon the polynucleation of the metal hydroxide through ageing. Under appropriate conditions such compounds as $(NH_4)_3[Nb(OH)_2 \times (C_6H_4O_2)_3] \cdot H_2O$ may be isolated. This compound absorbs at 340 mμ in ethanol but is immediately hydrolyzed in water or aqueous alkali and subsequently, within certain limits of OH^- concentration, a species absorbing at 310 mμ—probably a 1 : 1 complex and containing polynuclear niobic acid units—is slowly formed. Infra-red absorption measurements give no evidence of the presence of a niobyl radicle, NbO, in the solids. Tantalum hydroxide is much less easily dissolved in catechol than niobium hydroxide and the products contain about 5 moles of catechol to each tantalum atom. (auth)

32997 THERMODYNAMIC PROPERTIES AND PHASE RELATIONS IN THE SYSTEM HYDROGEN–HAFNIUM. Russell K. Edwards and Ewald Veleckis (Illinois Inst. of Tech., Chicago). J. Phys. Chem., 66: 1657-61(Sept. 1962).

Isothermal equilibrium pressure measurements were carried out as a function of composition for the hydrogen–hafnium system in the temperature range 251 to 872° and up to a pressure of one atmosphere. The proposed partial phase diagram indicates the existence of three homogeneous phases. In the primary solid solution phase (α) the solubility of hydrogen reaches nearly 11 atom % hydrogen at the highest temperature investigated but decreases considerably toward the lower temperatures. Conformance to Sieverts' law was established throughout the α-phase; the temperature variation of the Sieverts' law constant can be expressed by the equation $\log (\sqrt{P_{mm}}/N_H) = 3.820 - 1964T^{-1}$, where P_{mm} is the pressure of hydrogen and N_H is the atom fraction of hydrogen in the condensed phase. The second phase (δ) is homogeneous from a minimum composition of 24% at the highest temperature to a maximum of about 64% at lower temperatures. In the pressure range studied this latter boundary remains essentially constant with temperature. A very narrow two-phase region separating the δ-phase and a third phase (ε) is inferred with the latter extending to $HfH_{1.97}$ for our lowest temperature. The extrapolated phase boundaries show a good correlation with the room temperature x-ray studies of Sidhu and McGuire. The relative partial molal and integral heats and entropies are presented for the composition range 0 to 57 atom % hydrogen. The heat and entropy of the $\alpha \rightarrow \delta$ reaction are -15.66 ± 0.84 kcal/g-atom H and -12.34 ± 0.28 cal/deg g-atom H; for the $\delta \rightarrow \epsilon$ reaction the respective quantities are -13.39 ± 0.21 kcal/g-atom H and -20.64 ± 0.16 cal/deg g-atom H. (auth)

32998 CALORIMETRIC INVESTIGATIONS OF LIQUID SOLUTIONS OF THE ALKALINE EARTH NITRATES IN THE ALKALI NITRATES. O. J. Kleppa (Univ. of Chicago). J. Phys. Chem., 66: 1668-71(Sept. 1962).

Some new calorimetric data are presented for the solutions of strontium and barium nitrate in liquid sodium, potassium, rubidium, and cesium nitrates. It is shown that the limiting heats of solution of the alkaline earth nitrates in the alkali nitrates obey semi-empirical relations of the type already found for calcium nitrate: $\Delta\overline{H}_{M\epsilon(NO_3)_2} \cong A - 225[(r_{++/2} - r_{+/1})/(d_1 + d_2)]^2$ kcal/mole. In this expression r_{++} and r_+ are the ionic radii of the two cations (which have charges +2 and +1), while d_1 and d_2 are the sums of the ionic radii in each of the two solution partners. The parameter A depends on the choice of reference state, and varies from solute to solute. For undercooled, liquid calcium nitrate at 350° A ≅ 0.3 kcal/mole. The corresponding values for strontium and barium nitrates at 450° are approximately +0.6 and +0.8 kcal/mole, respectively. (auth)

32999 EVIDENCE FROM NUCLEAR MAGNETIC RESONANCE FOR MALATE COMPLEXES OF ALKALI METAL CATIONS. Luther E. Erickson and R. A. Alberty (Univ. of Wisconsin, Madison). J. Phys. Chem., 66: 1702-5 (Sept. 1962).

A pronounced concentration dependence is observed in the high-resolution proton NMR spectra of D_2O solutions of all five of the alkali metal malates. By contrast, the spectrum of tetramethylammonium malate is independent of concentration. These observations suggest that there is appreciable ion association in the alkali metal malate solu-

tions. From the magnitude of the concentration effects on spin-spin coupling constants and chemical shifts, the dissociation constant of the complex, CM^- (where C is any alkali metal ion), is estimated to be about 10 M. (auth)

33000 CONDUCTANCE OF THE ALKALI HALIDES. IV. RUBIDIUM BROMIDE IN DIOXANE-WATER MIXTURES. John E. Line, Jr. and Raymond M. Fuoss (Yale Univ., New Haven). J. Phys. Chem., 66: 1727-9(Sept. 1962).

The conductance of rubidium bromide was measured at 25° in dioxane–water mixtures, the dielectric constants of which cover the range from 13.01 to 78.54. The data are fitted by the Fuoss-Onsager conductance equation within the experimental precision of 0.006 to 0.05%. Association is negligible down to a dielectric constant of 30.43 where $K_A = 13 \pm 2$. As in the cases of potassium chloride and cesium iodide, the contact distance a_J increases (from 3.1 to 5.5 Å.) with decreasing dielectric constant. (auth)

33001 THE PREPARATION OF SOME RARE EARTH FORMATES AND THEIR CRYSTAL STRUCTURES. I. Mayer, M. Steinberg, F. Feigenblatt, and A. Glasner (Hebrew Univ., Jerusalem). J. Phys. Chem., 66: 1737-8 (Sept. 1962).

The formates of Ce, Pr, Nd, and Sm were prepared and found to correspond to the formula $M(HCOO)_3 \cdot 0.2\ H_2O$. The water could be removed only heating to 300°C with simultaneous decomposition of the formates. X-ray diffraction studies of powdered samples were of the hexagonal pattern, and unit cell dimensions of the formates are given. Comparison of calculated and observed intensities for Nd formate showed that the formates are isomorphous with Gd formate. (D.L.C.)

33002 LATTICE FREQUENCIES AND ROTATIONAL BARRIERS FOR INORGANIC CARBONATES AND NITRATES FROM LOW TEMPERATURE INFRARED SPECTROSCOPY. R. A. Schroeder, C. E. Weir, and E. R. Lippincott. J. Research Natl. Bur. Standards, 66A: 407-34(Sept.-Oct. 1962).

Infrared absorption spectra of inorganic nitrates and carbonates were obtained on single crystals at room temperature, under liquid nitrogen and liquid helium refrigeration. Diffuse absorption observed in the room temperature spectra between about 1400 and 700 cm^{-1} is resolved under liquid helium refrigeration into a large number of bands not attributable to fundamentals or combinations of fundamental frequencies of the anions. Almost all of these bands are readily interpreted as summation bands of fundamental frequencies with successive levels of a librating oscillator. The libration is considered to represent a planar torsional oscillation of the anion about the trigonal axis. The librational frequency depends in part on the crystal structure and on the ions. In a given material the librational frequency as determined from successive bands is reasonably constant. In the substances studied the librational frequency varied from about 15 to 30 cm^{-1}. Band limits observed in the spectra are interpreted as representing rotational energy barriers. These barrier heights are approximately 200 cm^{-1} with some dependence on the crystal structure and the ions involved. Barrier heights calculated from a cosine potential function agree reasonably well with the observed barriers for the cubic and calcite structures. Similar calculations were not made for other structures studied because of doubtful assignments or unknown structural details. In particular, spectra of the aragonite structures are remarkable in detail and complexity, and were not analyzed. However, the details of these and all other spectra studied appear to involve similar phenomena. (auth)

33003 ABSORPTION SPECTRA OF URANYL ACETATE AND NITRATE. K. V. Narasimham (Madras Inst. of Tech.). J. Sci. Ind. Research (India), B, 21: 468-73 (1962). (In English)

Analyses of the absorption bands of uranyl acetate and nitrate were carried out utilizing the results obtained from the polarization characteristics in the absorption spectra of single crystals in different directions at liquid air temperature. (auth)

33004 AN APPLICATION OF PAPER ELECTROPHORESIS TO THE EXAMINATION OF COMPLETENESS OF REACTION AND PURIFICATION IN THE SYNTHESIS OF RADIOACTIVE COMPOUNDS. Richard W. Meikle (Dow Chemical Co., Seal Beach, Calif.). Nature, 196: 61-2(Oct. 6, 1962).

The apparent electrophoretic mobility and quantitative distribution of radioactive compounds resulting from the reaction of bromoacetic-2-C^{14} acid with diethylenetriamine were determined by paper electrophoresis and radiometric analysis of autoradiograms of the delineated spots. [(Carboxymethylimino) bis (ethylenenitrilo)]tetraacetic acid labeled with C^{14} was obtained in 96 per cent purity with a specific activity of 4.8 mc/m mole. The procedure used is described in detail. (C.H.)

33005 EXCHANGE ADSORPTION OF RADIOACTIVE ION BY PACKED COLUMN OF KAOLINE TABLETS TREATED WITH SODIUM HYDROXIDE. Mutsumi Nishidoi (Kurita Central Lab., Japan). Nippon Genshiryoku Gakkaishi, 4: 530-4(Aug. 1962). (In Japanese)

Natural kaoline has relatively low cation exchange capacity, but the capacity can be increased remarkably by treatment with sodium hydroxide solution. Clays are dispersed in water as very small particles, so it is too difficult to separate them from the water. A kaoline tablet was prepared to prevent dispersion by binding with cellulose. Strontium was used as an adsorbate in packed column operation, because it was found that the kaoline had a higher selectivity for strontium than cesium. In a low flow rate, a capacity of 100 to 200 meq/100g was obtained for strontium. Cellulose did not affect the adsorption characteristics of strontium; however, the kaolinite tablet was swelled and deformed under the condition of a strong irradiation or acidity. (auth)

33006 LIQUID SODIUM ABSORBS GASEOUS IODINE. Richard J. Begley (Atomics International, Canoga Park, Calif.). Nucleonics, 20: No. 10, 100(Oct. 1962).

Experiments were conducted to study the sorptive properties of liquid Na at 500 and 1000°F for I_2. Capsules containing I_2 were punctured at depths of 6 and 10 ft in a liquid Na pool, N_2 gas was used to sweep out the cover gas and passed through a charcoal filter, and the filter was analyzed for I_2 after the cover gas was displaced ~5 times. The amount of I_2 found in the filter varied from 1.5% for a total amount of 0.6 mg to less than 0.1% for 60 mg. (D.L.C.)

33007 A STUDY OF COMPOSITION OF AMMONIUM URANATES. Andrzej Deptula (Inst. of Nuclear Research, Warsaw). Nukleonika, 7: 265-75(1962). (In English)

Potentiometric and analytical studies showed that polymerization of UO_2^{2+} ion to $UO_2[(OH)_2UO_2]_4^{2+}$ is the first stage of the reaction between uranyl nitrate and ammonia. The $UO_2[(OH)_2UO_2]_4^{+2}$ ion reacts with NH_4^+ to form ammonium uranate. Further course of reaction depends on the way in which ammonia is added. If ammonia is added slowly and the solution is allowed to stand till pH is established, an easily filtrable ammonium uranate is formed with the hypothetical composition $[(NH_4)_2O]_3 \cdot [UO_3 \cdot H_2O]_{20} \cdot 13H_2O$ which reacts further to form $[(NH_4)_2O]_5 \cdot [UO_3 \cdot H_2O]_{20} \cdot$

$7H_2O$. A rapid addition of ammonia leads to the formation of a poorly filtrable precipitate with the composition $[(NH_4)_2O]_{2.5} \cdot [UO_3 \cdot H_2O]_{20} \cdot 14H_2O$, which easily undergoes hydrolysis. The uranate, retaining its physical shape, reacts with the excess of ammonia to form a compound, composition of which corresponds approximately to $[(NH_4)_2O]_5 \cdot [UO_3 \cdot H_2O]_{20} \cdot 7H_2O$. (auth)

33008 REMARKS ON THE CHEMISTRY OF MENDELEVIUM. Mieczyslaw Taube. Nukleonika, 7: 389-406 (1962). (In Polish)

Some problems encountered in possible chemical investigations of transeinsteinium elements with half lives more than 10 minutes, including mendelevium, are discussed. Some experimental column methods (ion-exchange, extraction, ionophoresis, and coprecipitation) are proposed. A specific odd-even effect in the chemical properties of heavier actinides is investigated. (auth)

33009 EXCITON RECOMBINATION RADIATION AND PHONON SPECTRUM OF 6H SiC. W. J. Choyke and Lyle Patrick (Westinghouse Research Labs., Pittsburgh). Phys. Rev., 127: 1868-77(Sept. 15, 1962).

A photoluminescence spectrum consisting of about 50 lines is observed at low temperatures in 6H SiC. The spectrum can be attributed to exciton recombination after capture by un-ionized nitrogen atoms. The mechanism is similar to that for impurities in Si, but the large unit cell of 6H SiC (with 12 atoms) provides three inequivalent sites for nitrogen and 36 phonon branches, hence providing a large number of lines. Seventeen phonon energies are measured and plotted in a plausible way in an appropriate extended k space, leading to some conclusions about the band structure of 6H SiC. Spin-orbit splitting of the valence bands is only 4.8 mev, suggesting that the hole is confined to the carbon sublattice. Luminescence arising from the annihilation of free excitons is also observed. Absorption measurements are interpreted, making use of the 6H SiC phonon spectrum. (auth)

33010 INEQUIVALENT SITES AND MULTIPLE DONOR AND ACCEPTOR LEVELS IN SiC POLYTYPES. Lyle Patrick (Westinghouse Research Labs., Pittsburgh). Phys. Rev., 127: 1878-80(Sept. 15, 1962).

There is experimental evidence of three nitrogen donor levels in 6H SiC. The possibility of such multiple levels is a result of crystallographically inequivalent sites in the large unit cells of the common SiC polytypes. The existence of multiple levels indicates departures from the hydrogenic approximation. For x-ray scattering, the structure factor approximation in which polytypes are considered as various stacking orders of equivalent planes, may be inadequate. (auth)

33011 ELECTRON SPIN RESONANCE OF HYDROGEN ATOMS IN CaF_2. J. L. Hall and R. T. Schumacher (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 127: 1892-1912 (Sept. 15, 1962).

An investigation is carried out of the electron spin resonance of a hydrogen atom in an interstitial position in CaF_2. The following aspects of the problem are treated: apparatus and sample preparation; a spin Hamiltonian with four parameters describing the g value and hfs of the hydrogen atom with the eight equivalent fluorine nuclei surrounding it; the electron-nuclear double resonance spectrum and the resonance linewidth; and an attempt to calculate the parameters of the spin Hamiltonian starting from atomic and ionic wave functions. The sample preparation technique permits deuteration of the specimens, and spin Hamiltonian parameters are found for the deuterium center. Most of the data are obtained at room temperature, but some data are given on the hydrogen center at 77°K. An explanation of the small proton-deuteron and temperature-dependent differences of the spin Hamiltonian parameters is proposed. (auth)

33012 INFRARED PROPERTIES OF CaF_2, SrF_2, AND BaF_2. W. Kaiser, W. G. Spitzer, R. H. Kaiser, and L. E. Howarth (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 127: 1950-4(Sept. 15, 1962).

Reflectivity and transmission measurements on CaF_2, SrF_2, and BaF_2 are studied to obtain information on the lattice vibrations. The reflection band in each material is analyzed with classical dispersion theory. In order to fit the data, it is necessary to use one strong and one weak resonance in each case. The strong resonance is identified as the transverse optical mode of vibration for zero wave vector, and is at 38.9, 46.1, and 54.3 μ for CaF_2, SrF_2, and BaF_2 respectively. The long-wavelength value for the dielectric constant obtained from the optical measurements is in disagreement with the accepted value for SrF_2 obtained from capacity measurements. Capacity measurements are made, and show the accepted value for SrF_2 to be in error. The transverse optical-mode frequencies are shown to agree with the spacing of some of the satellite lines in the emission spectrum of Sm^{++} in these fluorides. (auth)

33013 NUCLEAR MAGNETIC RELAXATION IN THE PRESENCE OF PARAMAGNETIC IONS. [PART] II. Julius S. Dohnanyi (Sandia Corp., Albuquerque, N. Mex.). Phys. Rev., 127: 1980-2(Sept. 15, 1962).

The influence of independent processes of relaxation of paramagnetic ions on nuclear magnetic relaxation in the presence of these ions is treated. The nuclei are assumed to relax as a result of their contact with the ions through isotropic spin-exchange coupling. The second-order terms in the perturbation expansion of the relaxation tensor yield plausible contributions to the Bloch relaxation times of the nuclear spin system. The fourth-order terms yield contributions to the nuclear relaxation times that are in agreement with a phenomenological relation for this case, provided that the applied static field is not too strong and that the ionic motion can be described by a single Bloch relaxation time. (auth)

33014 ELECTRON SPIN RESONANCE OF Gd^{3+} AND Eu^{2+} IN SINGLE CRYSTALS OF CaO. Alexander J. Shuskus (United Aircraft Research Labs., East Hartford, Conn.). Phys. Rev., 127: 2022-4(Sept. 15, 1962).

Single crystals of CaO doped with Eu^{2+} and Gd^{3+} are investigated by paramagnetic resonance at the X band. Measurements are made at 290, 77, and 4.2°K. The spectra of Eu^{2+} and Gd^{3+} can be described by a cubic spin Hamiltonian. The constants for the spectrum of Gd^{3+} at 290°K are given. The over-all splitting of the ground state is $(380 \pm 4) \times 10^{-4}$ cm^{-1}. The constants for the spectrum of Eu^{2+} at 290°K are also given. The over-all splitting of the ground state is $(781 \pm 20) \times 10^{-4}$ cm^{-1}. The splitting parameters are found to vary only slightly between 290 and 4.2°K. (auth)

33015 K X-RAY ABSORPTION SPECTRA OF GERMANIUM IN CRYSTALLINE AND IN AMORPHOUS GeO_2. W. F. Nelson (Owens-Illinois Technical Center, Toledo), I. Siegel, and R. W. Wagner. Phys. Rev., 127: 2025-7 (Sept. 15, 1962).

The Ge K x-ray absorption spectrum is measured in three forms of GeO_2: hexagonal crystalline; tetragonal crystalline; and amorphous. From the measured results it is concluded that either the explanation of the extended fine structure observed in the spectra needs to be modified or that "glassy" GeO_2 is actually crystalline in character over small regions, i.e., that the amorphous GeO_2 has a

high degree of short-range order identical to that of the hexagonal crystalline form. (auth)

33016 SPECIFIC HEAT OF $Gd(NO_3)_3 \cdot 6H_2O$ IN THE TEMPERATURE RANGE BETWEEN 1.3 AND 220°K. K. H. Hellwege, W. Pfeffer, and H. J. Thiel (Technische Hochschule, Darmstadt, Ger.). Z. Physik, 168: 474-7(1962). (In German)

The specific heat of $Gd(NO_3)_3 \cdot 6H_2O$ was determined calorimetrically in the temperature range 1.3 and 220°K. Only at T < 5°K was there a significant contribution of the 4f electrons to the specific heat. For T < 220°K, the specific internal lattice energy and the specific lattice entropy were given. (tr-auth)

33017 REACTIONS OF ZIRCONS WITH CARBONATES AT ELEVATED TEMPERATURES. I. M. Kuleshov and G. I. Shmanenkova. Zh. Prikl. Khim., 35: 1686-90(Aug. 1962). (In Russian)

Reactions of zircons with alkali carbonates and alkaline earth metals in the solid state culminate at 900°C. Additions of fluorine increase the rate of zircon disintegration, however, in the presence of calcium carbonate, admixtures of sodium carbonate are more effective disintegration agents than fluorine. (R.V.J.)

33018 SORPTION OF URANIUM(VI) BY SULFOCATIONS. A. I. Zhukov, E. I. Kazantsev, V. M. Markova, and V. B. Pavlovich (Urals Polytechnic Inst., USSR). Zh. Prikl. Khim., 35: 1696-1702(Aug. 1962). (In Russian)

Investigations of U(VI) sorption from 0.05M uranyl nitrate solution by KU-1, MSF-3, KU-2, SDV-3, and SBS-1 sulfocations indicate that at pH > 2.5 the sorption exceeds the exchange volume with sulfo-groups, strongly depends on the type of resins, and does not vary with temperature from 0 to 80°C. Complex compounds formed by adsorbed ions and resins interfere with complete U(VI) elution by stoichiometric neutral ammonium chlorides and nitrates. (R.V.J.)

33019 THE PROCESS OF ANODIC GRAPHITE OXIDATION. O. S. Ksenzhek and V. M. Chaikovskaya (Dnepropetrosk Inst. of Chemistry and Tech., USSR). Zh. Prikl. Khim., 35: 1786-90(Aug. 1962). (In Russian)

The rate of anodic oxidation of graphite at increased potential was analyzed. A stationary potential of about 150 mv more negative than the equilibrium oxygen potential (in a solution of pH 0 to 5) is established following continuous graphite anode polarization. The kinetic characteristics of further oxidation (current of 3.5×10^{-12} amp/cm^2 at 20°C and 4.2×10^{-10} amp/cm^2 at 80°C and an activation energy of 16.6 kcal) were determined. (R.V.J.)

33020 GEKSAFTORID PLUTONIYA EGO POLUCHENIE I SVOISTVA. (Preparation and Properties of Plutonium Hexafluoride). N. P. Galkin, L. A. Ponomarev, and Yu. D. Shishkov. Moscow, Gosatomizdat, 1961.

Data on plutonium dioxide and tetrafluoride fluorination and on physical, chemical, and thermodynamic properties of the prepared hexafluoride are reviewed. Descriptions are given of laboratory equipment used in plutonium hexafluoride preparation, purification, storage, and identification. Protective measures used in handling plutonium hexafluoride are discussed. (R.V.J.)

Radiation Chemistry and Radiochemistry

Refer also to abstract 32676.

33021 (AERE-R-3950) A LITERATURE SURVEY ON RADIATION INDUCED POLYMERISATION IN THE SOLID STATE. J. V. Bennett and P. J. Fydelor (United Kingdom Atomic Energy Authority. Research Group. Wantage Research Lab., Wantage, Berks, England). July 1962. 44p.

A survey was made of the literature relating to radiation induced solid state polymerization published up to February 1962. Particular interest is directed to the relatively few monomers which have been found to yield stereospecific polymers. Following a brief account of the history of chemical and radiation initiated solid state polymerizations, the report discusses the various experimental conditions, mechanisms, and the determination of polymerization rates. Over twenty monomers are reported to polymerize in the solid state and each of these is considered separately in the second half of the report. (auth)

33022 (ANL-6556) MATHEMATICAL FORMULATION, ANALYSIS, AND DESCRIPTION OF THE FRICKE DIFFUSION KINETICS CODE. Erwin H. Bareiss, Cynthia Chamot, and Hugo Fricke (Argonne National Lab., Ill.). May 1962. Contract W-31-109-eng-38. 85p.

Based on the classical theory of diffusion and reaction kinetics, the kinetics of radiation of chemical reactions in fluid systems is represented by a system of parabolic partial differential equations. A code for the solution of a mathematical model which allows up to two radicals and two solutes to be present simultaneously is devised; it gives the concentrations as functions of time and space, and the recombination integrals as functions of time. When the model is applied to water, the radicals may be thought of as H and OH, and the solutes as forming together a redox couple. The reactions are thought to be initiated either by a narrow beam of γ rays or α particles. (auth)

33023 (GA-2512) THE HIGH-TEMPERATURE CHEMISTRY OF FISSION-PRODUCT ELEMENTS. Summary Report, August 1, 1960–July 31, 1961. U. Merten, W. E. Bell, and J. D. Hale (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Aug. 29, 1961. Contract AT(04-3)-164. 37p.

A report is presented in which work on the high-temperature chemistry of the Cl–Rh system, the Cl–Os system, the Cl–Ru system, and the Cl–Pd is summarized. Other work is described on diffusion and kinetic effects in the transpiration method, and the chemistry of transition metal chlorides. (J.R.D.)

33024 (TID-16773) NATURE OF THE PRODUCTS FORMED BY γ-IRRADIATION OF DEAERATED AQUEOUS POTASSIUM OLEATE. David R. Howton (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology). [1961]. Contract [AT (04-1)-Gen-12]. 54p.

Dilute deaerated aqueous solutions of potassium oleate were gamma-irradiated to observe the effects of radio-induced products of water on the hydrocarbon maieties of lipids. Transolifinic unsaturation was found to reside principally in a family of dimers differing in unsaturation and in location of cross-linkage. Possible mechanisms by which the major products might be formed are discussed in terms of their structures and their yields per unit energy absorbed by the irradiated solution. (J.R.D.)

33025 (AEC-tr-4499) RADIOCHEMICAL PROCEDURES: WORK WITH RADIOACTIVE ISOTOPES. Ivan Draganić, Olga Gal, and Milorad Radotić, eds. Translation of "Radiohemiski Praktikum: Rad sa Radioaktivnium Izotopima" (a publication of the Federal Nuclear Energy Commission, Belgrade, 1959). 499p.

The information is presented in a book comprised of chapters on the structure of atoms and atomic nuclei, the passage of radiation through matter, radioactive decay and radioactive equilibrium, the production of radioactive iso-

topes, statistical principles of radioactive measurements, ionization counter devices, scintillation counter devices, the technique of radioactive measurements, determination of the energy of radiation by absorption, determination of half-life, employment of carriers in radiochemistry, electrochemical methods, chromatography, isotopic dilution, radiochemical laboratories, radioprotection, radioisotopes decontamination and waste disposal, accident procedures, dose calculation, radiation effects, and aspects of radiochemistry. (J.R.D.)

33026 STUDY OF THE RADIATION STABILITY OF FLUORINATED OIL. V. N. Cherednikov. At. Energ. (USSR), 13: 74-5(July 1962). (In Russian)

Fluorinated aliphatic oil, C_nF_{2n+2}, is a colorless, neutral liquid with a density of 2g/cm^3, a boiling point of 170°C, and a viscosity not exceeding 200 centipoise; it has a low capture cross section and is a good moderator. The material was exposed to a flux of 5×10^{12} n/cm^2 thermal neutrons and 3×10^{12} n/cm^2 1.5-Mev neutrons. A temperature increase up to 200°C was noted after the integrated dose of 18.8 and 32 megarad. During the exposure the amount of the evolving gas was measured; the fractional composition and the viscosity of the oil were also determined. It was found that the chief component of the liberated gas is CF_4; no noticeable amounts of F_2 were detected. The gas was equivalent to 1.8 ± 0.2 mole per 100 ev of absorbed dose. This value is higher than the corresponding value of H_2 for the aromatic diphenyl $G_{H_2} = 0.01$ but agrees quite well with data obtained with aliphatic compounds. Exposure to an integrated dose of 10^{18} n/cm^2 resulted in a 990-fold increase of the viscosity. The radiation induced a marked polarization in the oil. (TTT)

33027 THE EFFECT OF REACTOR RADIATION ON THE PROPERTIES OF CADMIUM SULFIDE SINGLE CRYSTALS. A. P. Galushka and I. D. Konozenko. At. Energ. (USSR), 13: 277-80(Sept. 1962). (In Russian)

The conductivity of single crystals of CdS was previously found to increase as a result of gamma-induced defects which could be annealed out at 60°C. This problem was extended to an investigation of the effect of a neutron flux. The CdS specimens were subjected to a preliminary soaking at 600°C for 1 hour, after which the conductivity under darkness, the heat-induced conductivity, and the spectral light sensitivity were determined; they were then wrapped in Al and exposed to an integral flux of 10^{12}, 10^{14}, 10^{16}, and 10^{19} neutrons/cm^2 keeping the temperature below 50°C. The resistance under darkness was affected only slightly by exposure to the lower doses but it was reduced from 10^{11} to 10^{12} to 10^3 ohm after exposure to 10^{19} n/cm^2. Heating of the specimens to 200°C did not affect this value, indicating that the supplementary conductivity is due to donor atoms. Exposure to 10^{16} n/cm^2 increased the photosensitivity by an order of magnitude. Curves of the heat-induced conductivity allowed determination of the location of impurity centers. It was concluded that changes of the photoelectric properties are not due to foreign chemical elements but to In atoms from the reactions $Cd^{114} + n \rightarrow Cd^{115} \xrightarrow{\beta^-} In^{115}$; $Cd^{116} + n \xrightarrow{\beta^-} Cd^{117} \xrightarrow{\beta^-} In^{117} \xrightarrow{\beta^-} Sn^{117}$. The radioactive S isotopes S^{34} and S^{38} yield ultimately Cl^{35} and Cl^{37} but because of their relatively long half life they do not affect the conductivity. (TTT)

33028 POLYMERIZATION BY THE ACTION OF X RAYS. Jean-Jacques Trillat and Claude Sella (CNRS, Bellevue, France). Bull. Acad. Natl. Med. (Paris), 146: 178-82(Mar. 1962). (In French)

The kinetics of the polymerization of acrylic amide under the influence of x radiation was followed by electron microscopy by observing the formation of macromolecules from crystals of the monomer. Light microscopic examination of the polymerization process showed that it is not homogeneous within the crystal and that the monomer and polymer form 2 phases. Irradiated crystals, examined by the replication technique, show marked differences from nonirradiated crystals and different stages of polymerization can be observed. Polymerization does not occur haphazardly but in a statistical fashion at sharply localized points of dislocation of crystalline regions of monomer. The points appear as a series of microparticles aligned in the direction of the crystalline axis. These round particles of ~20 Å diameter represent macromolecules forming from monomer molecules. With continued irradiation of the crystal these particles continue to develop, reaching a diameter of 300 to 400 Å or more, and as chains of growing particles coalesce, fibrous structures are formed. Eventually, the entire crystal assumes a fibrous appearance, but at high magnification the fibers appear as chains of globular microparticles. These results show the heterogeneous character of radiation-induced polymerization and the formation of a 2-phase (monomer-polymer) system. The centers of polymerization apparently form at radiation-induced dislocations of monomer crystal structure, and these are propagated by strains and deformations resulting from incipient polymerization. (H.H.D.)

33029 THE RADIATION CHEMISTRY OF OXYANIONS OF TRANSITION ELEMENTS. PART II. REDUCTION OF PERMANGANATE AND MANGANATE IONS IN KOH SOLUTIONS BY γ ^{60}Co RAYS. B. Jezowska-Trzebiatowska and J. Kaleciński (Wrocław Univ., Poland and Inst. of Physical Chemistry, Polish Academy of Sciences, Wrocław). Bull. acad. polon. sci. Ser. sci. chim., 10: 241-6(1962). (In English)

The mechanism of MnO_4^- reduction induced by γ rays in the presence of a large quantity of MnO_4^{2-} was investigated. Samples of 7 ml were irradiated at dose rates of 7.95×10^{16} and 7.75×10^{16} ev/ml min. The changes of MnO_4^- and MnO_4^{2-} concentrations caused either by reduction or disproportionation were negligible owing to the short duration of the radiation reaction in comparison. After irradiation the samples were centrifuged and the extinction was measured with a spectrophotometer at 530 and 610 mμ. Permanganate and manganate concentrations were calculated. The reduction of permanganate induced by gamma rays may be divided into two periods. In the first stage the concentration of MnO_4^- ions decreased linearly with irradiation time while the concentration of MnO_4^{2-} increased. After reaching a maximum, manganate concentration decreased with irradiation time. (M.C.G.)

33030 ISOTOPE EFFECTS IN NEUTRAL H_2O–D_2O IRRADIATED SOLUTIONS AND THE NATURE OF THE REDUCING RADICAL. Chava Lifshitz (Hebrew Univ., Jerusalem). Can. J. Chem., 40: 1903-8(Oct. 1962).

Neutral solutions of sodium formate in H_2O–D_2O mixtures were irradiated by 200-kv x rays. The atomic deuterium isotope effect (α_A) and its dependence on deuterium concentration were determined. In a 1×10^{-1} M HCOONa, 96% D_2O solution, G(hydrogen) = 1.14 and $\alpha_A = 4.3$. It is concluded that the hydrogen atom cannot be formed from a single water molecule. Possible mechanisms of hydrogen atom formation are discussed. The alternative possibilities for the atoms to react as H or H_2O^- are viewed in the light of the proposed mechanisms. (auth)

33031 SOME UNIQUE REACTION IN RADIATION CHEMISTRY—POLYMERIZATION IN CRYSTALLINE STATE. Seizo Okamura (Kyoto Univ.). Chem. (Japan), 17: 387-91 (1962). (In Japanese)

33032 SOME THERMODYNAMIC STUDIES ON GAMMA IRRADIATED INORGANIC NITRATES. Jeremy Forten (Stevens Inst. of Tech., Hoboken, N. J.). Dissertation Abstr., 23: 457(Aug. 1962).

Sodium, potassium, cesium, and lead nitrates were irradiated with gamma rays from a Co^{60} source. The effects of radiation on the nitrates were studied as a function of absorbed dose, by determining the extent of chemical decomposition, changes in heat of solution, density changes, and by obtaining the reflectance spectra and infrared spectra of the irradiated salts. The results indicate that radiation effects are sufficiently different in each salt as to require individual interpretation in each case. However, one significant radiation effect common to all the salts is that they undergo a lattice transition to a relatively stable form, which occurs before the salt has undergone 2% decomposition. There are indications that the lattice transition is caused by the necessity of the salt to accommodate products of decomposition.

33033 RADIATION-INDUCED EFFECTS ON WATER-SOLUBLE POLYMERS IN AQUEOUS SOLUTIONS. I. PARTIALLY ACETYLATED POLYVINYL ALCOHOL. Tatsuo Matsuda and Chen-chong Lin (Chien-chung Lin). Dōitai to Hōshasen, 4: 38-45(May 1961).

The effects of polymer structure and composition on radioinduced changes in water-soluble polymers were studied by using 0.22% solutions of PVA and PVAAc irradiated with Co^{60} at 6.6×10^4 r/hr in air and at room temperature. The degree of main chain scission increased linearly with the irradiation time. The G-value was larger for the diluted PVAAc than for the PVA, but the G value of cross-linking of the concentrated solution was smaller for PVAAc than for PVA. Therefore, it was concluded that both the rates of degradation and cross-linking for PVA in aqueous solution depended largely upon and were approximately proportional to the amount of vinyl acetate unit in its polymer chain. (OID)

33034 IRRADIATION OF POTASSIUM CHROMATE FOR PRODUCTION OF Cr^{51} BY NUCLEAR RECOIL. R. Constant (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Ind. chim. belge, No. 6, 657-62(1962). (BLG-121). (In French)

The possibilities of producing chromium-51 with high specific activity by making use of the Szilard-Chalmers effect upon potassium chromate is studied. The most favorable irradiation conditions in the BR1 reactor (Mol, Belgium) are defined. It is shown that in such a reactor the quantity of chromium-51 extracted by precipitation increases with the thermal flux, whereas the specific activity increases with the flux level. (auth)

33035 IONIC AND FREE RADICAL PROCESSES IN THE RADIOLYSIS AND SENSITIZED PHOTOLYSIS OF BENZENE SOLUTIONS. William Van Dusen, Jr. and William H. Hamill (Univ. of Notre Dame, Ind.). J. Am. Chem. Soc., 84: 3648-58(Oct. 5, 1962).

The gamma radiolysis of various binary liquid mixtures, mostly with benzene as one component, was observed over the complete range of composition, for the primary purpose of correlating chemical effects with dissociative electron attachment and also to obtain evidence for positive charge exchange. Parallel measurements of benzene photosensitized decomposition at 2537 Å were also performed to establish the quantum efficiency of energy transfer. Systems included various alkyl chlorides, bromides, and iodides as well as chloroform, carbon tetrachloride, phenylacetyl chloride and benzyl acetate, all with benzene, as well as chlorobenzene–chloroform and methyl iodide–carbon tetrachloride. In conjunction with other evidence (P. S. Rao, et al., J. Am. Chem. Soc., 84: 500(1962)), the results support the hypothesis that dissociative electron attachment is an important primary process in the radiation chemistry of liquid systems with components which can readily attach slow electrons in the low pressure gas. Attachment can produce a large sensitized radiolysis of a minor component of the system. Positive charge transfer is indicated by a marked depression of G(product) from carbon tetrachloride, chloroform, or benzyl acetate for small additions of benzene. It is concluded that evidence from luminescence of solutes demonstrates the very minor role in radiation chemistry of energy transfer from singlet states. (auth)

33036 ELECTRON SPIN RESONANCE OF A γ-IRRADIATED SINGLE CRYSTAL OF TRIFLUOROACETAMIDE. Robert J. Lontz and Walter Gordy (Duke Univ., Durham, N. C.). J. Chem. Phys., 37: 1357-66(Sept. 15, 1962).

Electron spin resonance measurements made on γ-irradiated single crystals of CF_3CONH_2 show that the irradiation breaks a CF bond to leave the detectable free radical CF_2CONH_2. Although the structure of the crystal is unknown, its form is approximately monoclinic. The study indicates that there are two molecules in the unit cell. The free radicals formed from these appear to be planar with their planes parallel to the two crystal faces, ac and bc, which have relative orientations of 68°. Nuclear couplings of the two F atoms of the free radical are equivalent and are symmetrical about an axis perpendicular to the plane of the free radical with principal elements parallel and perpendicular to the symmetry axis: $A_\parallel = 178$ G, $A_\perp = 24$ G. The elements of g are also axially symmetric, and their principal axes have the same direction as those of A, with $g_\parallel = 2.0025 \pm 0.0010$ and $g_\perp = 2.0045 \pm 0.0010$. It is concluded that the electron spin density is in a π orbital perpendicular to the plane of the free radical with approximately 11% of the density in a p orbital of each of the F atoms. The isotropic component in the F^{19} coupling can be attributed to spin polarization of the σ CF bonds, if it is assumed that the bonding orbital of the F has about 33% s character. Off-diagonal terms in the nuclear coupling give rise to satellite components which for some orientations at 24 kMc/sec are one-fifth as strong as the principal lines. (auth)

33037 RADIATION CHEMISTRY OF ORGANIC HALOGEN COMPOUNDS. PART II. THE ACTION OF γ-RADIATION ON ALLYL HALIDES. D. Leaver, A. H. McQuillan, W. Miller, and H. W. W. Ehrlich (Univ. of Edinburgh). J. Chem. Soc.: 3331-6(Sept. 1962).

The yield of polymer formed by γ irradiation of the allyl halides decreases in the sequence, chloride, bromide, iodide. A liquid polymer is the only product from the chloride but small amounts of at least ten other compounds accompany the dimer which is the main product from allyl bromide. Iodine and hexa-1,5-diene are produced during irradiation of the iodide. (auth)

33038 RADIOLYSIS OF CARBON DIOXIDE. A. R. Anderson, J. V. Best, and D. A. Dominey (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Chem. Soc.: 3498-3503(Sept. 1962).

The radiolysis of carbon dioxide in the presence of sulfur dioxide and nitrogen dioxide as scavengers was studied by using the Harwell nuclear reactor, BEPO, and two different sources of γ radiation. The measured G value for carbon monoxide production is 3.51 ± 0.23 for γ radiation. Possible reasons for the discrepancy between this value and previous data are discussed. Uncertainties in the

methods of dosimetry used for reactor radiation are discussed and it is concluded that G(CO) for reactor radiation agrees with the value for γ radiation within the limits of these uncertainties. (auth)

33039 ISOTOPE EFFECTS IN THE ABSTRACTION OF HYDROGEN FROM ETHANOL BY HYDROGEN ATOMS IN IRRADIATED AQUEOUS SOLUTIONS. Chava Lifshitz and Gabriel Stein (Hebrew Univ., Jerusalem). J. Chem. Soc.: 3706-12(Sept. 1962).

The reaction, $RH + H \rightarrow H_2 + R$, was investigated in aqueous ethanol and t-butyl alcohol at a low pH. By isotopic labeling of the water and/or the ethanol the sites of attack on the ethanol molecule were determined and the degree of selectivity in abstraction was found. The attack on the hydrogen atoms of the ethanol is in the order, α-H > β-H > OH ≈ 0. The isotope effect in the abstraction from an α-C–H bond compared with an α-C–D bond is calculated. The results for ethanol and t-butyl alcohol are correlated. The results are discussed in the light of previous information concerning the radiation chemistry of alcohols. (auth)

33040 THE RADIOLYSIS OF SATURATED HYDROCARBONS. T. J. Hardwick (Gulf Research and Development Co., Pittsburgh). J. Phys. Chem., 66: 1611-19(Sept. 1962).

The yields of primary products in the radiolysis of some twenty saturated hydrocarbons (C_5–C_{19}) were measured. For all paraffins investigated, the yield of "molecular" hydrogen gas is approximately a constant fraction of the total hydrogen gas (0.40) despite changes in hydrocarbon structure and total hydrogen gas yield. Evidence is presented which indicates that this "molecular" hydrogen arises by a "hot" hydrogen atom mechanism rather than by a molecular detachment process. The balance of the hydrogen gas formed arises from the reaction of radiolytically produced chemical hydrogen atoms with the solvent. Congruent "molecular" unsaturation (olefins of the same carbon number produced in the presence of alkyl radical scavengers) ranges from 50 to 80% of the "molecular" hydrogen yield. Radicals produced by C–C bond scission interact within the cage of formation by disproportionation or recombination, or may escape from the cage to react with other radicals or solutes. Yields of such freely diffusing radicals were measured, and a definite relation to chemical structure was found. The results for all hydrocarbons studied are in complete agreement with the mechanism previously postulated for saturated hydrocarbon radiolysis. Determinations of free radical yields by e.p.r. give results in good agreement with other methods. (auth)

33041 γ-IRRADIATION OF ISOPROPYLBENZENE. Robert R. Hentz (Socony Mobil Oil Co., Inc., Princeton, N. J.). J. Phys. Chem., 66: 1622-5(Sept. 1962).

Cobalt-60 γ-irradiation of isopropylbenzene was studied in the liquid phase at 36 and 145° and in the gas phase over the temperature range 163 to 385° at pressures of 0.5 and 1.0 atm. Maximum G-values are obtained in the gas phase at 385° and are as follows (G-values for liquid-phase irradiation at 36° are in parentheses); isopropylbenzene reacted, 16 (1.8); polymer, 9 (1.7); methane, 3.4 (0.090); benzene, 2.8 (0.05); C_6-benzene, 2.3; hydrogen, 2.1 (0.179); C_3-benzene, 1.5 (0.04); propene, 0.56 (0.010); propane, 0.51 (0.011); toluene, 0.5; ethene, 0.23 (0.002); ethane, 0.07 (0.004); and acetylene, 0.05 (0.004). Radiolysis is compared with catalytic and non-catalytic thermal cracking. (auth)

33042 IRRADIATION OF ISOPROPYLBENZENE ADSORBED ON MICROPOROUS SILICA–ALUMINA. Robert R. Hentz (Socony Mobil Oil Co., Inc., Princeton, N. J.). J. Phys. Chem., 66: 1625-9(Sept. 1962).

Irradiation with cobalt-60 γ rays of a heterogeneous system consisting of isopropylbenzene and microporous silica–alumina was studied over the entire range of isopropylbenzene electron fraction, F, and with two solids of different surface areas. G(benzene) increases markedly relative to yields of all other products as F decreases and passes through a sharp maximum at very low F; yields for benzene formation and isopropylbenzene decomposition are higher in the presence of solid than in the pure liquid at the same temperature, 36°, even though the radiation is absorbed overwhelmingly in the solid. Characteristic G-values for the major products at low electron fraction are as follows for F = 0.0068; isopropylbenzene reacted, 3.8; benzene, 1.05; hydrogen, 0.208; methane, 0.0042. Interpretation of the maximum as due to saturation of sites effective in isopropylbenzene dealkylation permits a calculation for both solids of effective site concentrations which are in good agreement. The unique behavior of benzene yields and the higher per cent conversion of decomposed isopropylbenzene to benzene suggest that isopropylbenzene is chemisorbed on those sites effective in thermal dealkylation; that radiation produces in the solid electronic excitation of relatively long lifetime at room temperature; and that this excitation energy is transferred to chemisorbed isopropylbenzene, where it is utilized (with greater efficiency than in the liquid) for the reaction of dealkylation to which the isopropylbenzene is predisposed on the chemisorption sites. A different mechanism is postulated for hydrogen formation. (auth)

33043 RADIOCARBON-LABELLED COMPOUNDS PRODUCED BY THE NEUTRON IRRADIATION OF CRYSTALLINE ACETAMIDE. Thomas W. Lapp and Robert W. Kiser (Kansas State Univ., Manhattan). J. Phys. Chem., 66: 1730-2(Sept. 1962).

An investigation was made into the nature and relative amounts of the radiocarbon activities produced by dissolution in water of pile-neutron irradiated acetamide. The largest amounts of the activity isolated were present in propionamide, acetamide, acetylacetone, malonamide, and succinamide. Possible paths are suggested which lead to the final products observed in solution. (auth)

33044 RADIOLYSIS OF LIQUID 1,5-HEXADIENE. H. B. van der Heijde and C. D. Wagner (Shell Development Co., Emeryville, Calif.). J. Phys. Chem., 66: 1746-7 (Sept. 1962).

Radiolysis of liquid 1,5-hexadiene at −150 to +25°C gave H_2 (G = 0.45), C_3 (G = 0.42), C_{12} (G = 0.78), and heavier polymers (G_{-M} = 4.8). Cyclic products account for less than 10% of the total products. The results agree with the concept that condensation occurs by the ion-molecule mechanism. (D.L.C.)

33045 RADIATION-INDUCED EFFECTS ON WATER-SOLUBLE POLYMERS IN THEIR AQUEOUS SOLUTIONS. II. CO-CROSSLINKING BETWEEN TWO DIFFERENT POLYMERS. Tatsuo Matsuda, Chen-chong Lin (Chien-chung Lin), and Kiyoshi Hayakawa. Kōbunski Kagaku, 18: 492-5(Aug. 1961).

Aqueous solutions of 2 of the polymers PVA, PVP, PAM, MC, and PMAA, each with a 4% total concentration were irradiated by a 300-c Co^{60} source at 6.2×10^4 r/hr up to 1.0×10^6 at room temperature. Each polymer was also dissolved below its critical concentration for gelation. Results showed that networks between 2 different polymer components resulted if both were of the cross-linking type. However, gel formation was retarded if one of the 2 poly-

mers was of the degradative-type. Co-cross-linking was observed in the case of PVA + PVP, and the effects of irradiation on the viscosity and solubility of the polymers dissolved in methanol are discussed. A linear relationship existed between the gelation dosage and the content of the polymers in PVA + PVP and PVA + PAM. The network formation in the cross-linking-type polymers in aqueous solutions was retarded in the presence of methylcellulose. (OID)

33046 SEPARATION OF Cs^{137} AND Sr^{90} FROM A MIXTURE OF OLD FISSION PRODUCTS BY ELECTROPHORESIS ON PAPER. P. Gerontopulos and E. Lazzarini (CESNEF, Politecnico, Milan). Met. ital., 54: 300-4(July 1962). (In Italian)

Some results obtained in the separation of Cs^{137} and Sr^{90} from a mixture of fission products are described. Work was done on the following points: choice of the aptest electrolyte; determination of the band mobility; and study of the effects of temperature. The obtained results permit one to conclude that after 30 minutes with electric fields of 50 volt/cm it is possible to separate pure Cs^+ and Sr^{2+} from a mixture of fission products. But good separations are obtainable also in 15 minutes. Increasing the temperature raises the migration rate, but the bands widen notably and therefore a longer migration is necessary in order to get purer products. On the whole there is no gain of time. Considerable advantages were not obtained in practice by working at temperatures lower than room temperature. (auth)

33047 IRRADIATION-PRODUCED PARAMAGNETIC OXIDES OF NITROGEN IN SINGLE-CRYSTAL POTASSIUM AZIDE. D. Mergerian and S. A. Marshall (Armour Research Foundation, Chicago). Phys. Rev., 127: 2015-22 (Sept. 15, 1962).

A magnetic resonance absorption centered about g = 2 and showing no evidence of fine structure is reported in x-irradiated single crystals of potassium azide. Six absorption lines are detected that appear to exhibit axial symmetry about the crystal C direction. These lines are shown to be a composition of two distinct spectra, each consisting of three nuclear hyperfine components. For one set of lines, an anisotropic hyperfine splitting varying from 38 to 3 Oe is observed as the magnetic field is rotated from the crystal C axis to a direction perpendicular to this axis. The other set similarly exhibits splittings between 62 and 31 Oe. The inner and outer sets of lines are believed to be caused by NO and NO_2 molecules respectively, with both molecules located at crystal sites having axial symmetry. These molecular species are formed during the irradiation process, perhaps from nitrate and/or nitrite impurities contained in the lattice. Each of the three components of the outer set of lines exhibits a partially resolved seven-line multiplet structure which is interpreted to be the result of an interaction between the paramagnetic electron and the nuclei of two crystallographically equivalent nearest-neighbor potassium ions. (auth)

33048 THE DECOMPOSITION OF AQUEOUS SULFURIC ACID SOLUTIONS BY COBALT GAMMA RAYS. I. RADICAL AND MOLECULAR PRODUCT YIELDS FROM Ce(IV) SOLUTIONS IN 0.4 TO 18 M ACID. J. W. Boyle (Oak Ridge National Lab., Tenn.). Radiation Res., 17: 427-49(Oct. 1962).

With Ce(IV) and Ce(III) as radical scavengers for sulfuric acid solutions, the yields of radiolytic products have been determined between about 0.03 and 0.95 electron fraction sulfuric acid. The observed products are Ce(III), hydrogen, oxygen, peroxymonosulfuric acid, peroxydisulfuric acid, and sulfur dioxide. A model has been proposed which assumes that each chemical species present in solution gives rise to specific chemical intermediates when subjected to ionizing radiation. The principal species present in sulfuric acid solutions are H_2O, H_3O^+, HSO_4^-, SO_4^{--}, and H_2SO_4. Radical or radical ion intermediates postulated to arise by irradiation of the above-mentioned species are H, OH, HSO_4, SO_4^-, HSO_3, and SO_3^-. The relative number of each species decomposed depends on its electron fraction. Competitive electron capture processes may also affect the yields of some of the intermediates. The yield of each intermediate as a function of acid concentration is given in graphic form. (auth)

33049 THE DECOMPOSITION OF AQUEOUS SULFURIC ACID SOLUTIONS BY COBALT GAMMA RAYS. II. YIELDS OF SOLVENT DECOMPOSITION AND REDUCING RADICALS FROM Fe(II) SOLUTIONS IN 0.4 TO 18 M ACID. J. W. Boyle (Oak Ridge National Lab., Tenn.). Radiation Res., 17: 450-64(Oct. 1962).

Sulfuric acid 0.4 M to 18 M was studied with Fe(II) as a radical scavenger. The yields of observed products G(Fe (III)), $G(H_2)$, $G(SO_2)$, and $G(-O_2)$ were shown to be consistent with intermediates previously postulated. The total solvent decomposition yield, G(–(water + acid)) was obtained from this system and was used to calculate the yields of all the intermediates over the entire acid range studied. The acid-dependent hydrogen yield is explained on the basis of competition for H atoms by H_3O^+ and O_2 forming the complexes H_4O^+ and HO_2 which then react with Fe(II) on a noncompetitive basis. Oxygen appears to be about 700,000 times as reactive as H_3O^+ toward H atoms. (auth)

33050 THE HELIUM ION IRRADIATION OF LIQUID METHYL IODIDE. James Sturm and Harold A. Schwarz (Lehigh Univ., Bethlehem, Penna. and Brookhaven National Lab., Upton, N. Y.). Radiation Res., 17: 531-5(Oct. 1962). (BNL-5865)

Liquid methyl iodide has been irradiated by helium ions in the energy range from about 3 to 35 Mev. Yields of I_2, C_2H_6, CH_4, C_2H_4, C_2H_2, and H_2 are all higher than those observed in γ-radiolysis and increase with decreasing helium ion energy. The relative yield of acetylene, although small, increases more than twofold in going from 35-Mev to 3-Mev helium ions. Apparently all the above products are produced in combination reactions of radicals as they diffuse out of the spurs in which they are produced. It would appear that acetylene is produced in a secondary track reaction. (auth)

33051 2-PHENYLETHYL-2-C^{14} IODINE FROM THE IRRADIATION OF 2-PHENYLETHYL-1-C^{14} IODIDE WITH COBALT-60 GAMMA RAYS. C. C. Lee, D. G. Lee, and I.S. Bhardwaj (Univ. of Saskatchewan, Saskatoon, Can.). Radiation Res., 17: 536-42(Oct. 1962).

On irradiation of 2-phenylethyl-1-C^{14} iodide with Co^{60} γ-rays, 2-phenylethyl-2-C^{14} iodide was formed with a G value of 0.50 ± 0.05 for the dosage range of 8.8 to 47.9 million rads. The mechanism for this isotope position rearrangement likely involves a 1,2-phenyl shift of the 2-phenylethyl-1-C^{14} to 2-phenylethyl-2-C^{14} radicals. The G values for total decomposition of 2-phenylethyl iodide and for ethylbenzene formation were about 2 and 0.4, respectively. Radiolysis of ordinary 2-phenylethyl iodide showed that $G_{\frac{1}{2}I_2}$ was 2.0 ± 0.1 for the dosage range of 7.3 to 22.4 million rads. Another experiment with ordinary 2-phenylethyl iodide irradiated with 38 million rads showed G_{HI} to be 0.2 and that the organic products of radiolysis, measured by vapor phase chromatography, were styrene, ethylbenzene, and toluene in relative amounts of 82 : 17 : 1, respectively. (auth)

33052 STRUCTURE OF A RADIATION-INDUCED POLYMER FROM GLUCOSE. S. A. Barker, I. R. L. Lloyd, and M. Stacey (Univ. of Birmingham, Eng.). Radiation Res., 17: 619-24(Oct. 1962).

The major functional groups present in a radiation-damaged polymer obtained from glucose were assayed, and some details of the arrangement of hydroxyl, carbonyl, carboxylic acid, γ-lactone, etc., in the polymer were ascertained. Polymeric character was retained after acid hydrolysis, periodate oxidation, and other degradative reactions. (auth)

33053 THE EFFECT OF GAMMA IRRADIATION ON AN ALKALINE SOLUTION OF HEMIN. M. L. Amiragova, N. N. Koshcheenko, and A. V. Savich. Radiobiologiya, 2: 365-9(1962). (In Russian)

In 0.1 N NaOh, hemin (H) is converted to a new compound (H') having an intact porphyrin nucleus. The H' compound is insoluble in butanol. The effects of the initial concentration of hemin, of dissolved oxygen, and of the presence of inorganic peroxide ($Na_2S_2O_8$) were investigated on irradiating hemin in 0.1 N NaOH with Co^{60} gamma rays. The conversion of hemin to the H' form was followed by spectrophotometric measurements in the visible and ultraviolet regions of the spectrum, and by the molar adsorption coefficient of hemin at 385 mμ. At an initial concentration of 10^{-4} to 10^{-3} M hemin, the radiation yield for the conversion of hemin (H) to the butanol-insoluble form (H') follows the relation $[1 - \exp(-D/D_{37})]$, where D_{37} is the dose at which 37% of the initial hemin remains intact. In the absence of oxygen, hemin is converted only to the H' compound (having an intact porphyrin nucleus). Further decomposition of the H' compound with rupture of the porphyrin nucleus does not take place in the absence of oxygen. Persulfate ($Na_2S_2O_8$) converts hemin to a compound analogous to the H' compound. The presence of persulfate does not change the radiation yield for the conversion of hemin to the H' compound. On irradiating a frozen 0.1 N NaOH solution of hemin at −196°C (liquid nitrogen temperature), it was found that hemin is converted only to the butanol-insoluble form (H'). Peroxide (H_2O_2) formed by the radiolysis of water is responsible for the conversion of hemin to the H' form. On irradiating a 0.1 N NaOH solution at −196°C, and adding the hemin after thawing out the irradiated solution, it is observed that the hemin is converted to the H' form (maximum G yield observed is equal to 2.7 which is close to yield of H and OH radicals from the radiolysis of water). (TTT)

33054 STUDY OF THE REACTION OF TELOMERIZATION OF ETHYLENE AND CARBON TETRACHLORIDE INITIATED BY GAMMA RADIATION. C. David and P. A. Gosselain (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Tetrahedron, 18: 639-51(1962). (BLG-114). (In French)

The telomerization of ethylene and carbon tetrachloride was initiated with γ rays in the liquid phase. The effect of irradiation time, oxygen concentration, ethylene–carbon tetrachloride molar fraction, and temperature was studied on the radiochemical yield and nature of the reaction products. The transfer constants C_1 and C_2 were determined at different temperatures. Their temperature coefficient and entropy factor were calculated. The values found are discussed in regard with the rules and the experimental knowledge available for the study of gaseous free radical reactions. (auth)

33055 VENTILATION PROBLEMS IN RADIOCHEMISTRY. Hellmut Schmidt. Wiss. Z. Hochsch. Maschinenbau Karl-Marx-Stadt, 3: 69-74(1961).

Several methods for separating extremely fine particles (usually the carriers of activity) from the air employ precipitation chambers, centrifuges, dry and wet filtering devices, and electrostatic condensers. The construction and operation of these devices, which are controlled continuously by radiation monitors, are described. Experiences with most of the installations were quite satisfactory. They are based not only on principles of radiochemistry and health physics but comply also with laws and regulations concerning handling of radioactive preparations. (OID)

33056 STRUCTURE OF RADIATION PIPERYLENE POLYMER. A. I. Yakubchik and V. K. Smirnova. Zh. Prikl. Khim., 35: 1870(Aug. 1960). (In Russian)

Structure studies of γ-irradiated piperylene (0.72 r/sec to 198 Mr/r at room temperature) showed 6.5% 3, 4 links (with vinyl groups) and 67% trans- (1, 4 + 1, 2) links. The results indicate an irregular structure. (R.V.J.)

Raw Materials and Feed Materials

33057 INVESTIGATION OF THE PROPERTIES OF ION EXCHANGE RESINS USED FOR THE RECOVERY OF URANIUM AT VARIOUS TEMPERATURES. M. Fodor, E. Szabó, and Z. Pokó (Central Research Inst. for Physics, Hungarian Academy of Sciences, Budapest). Acta Chim. Acad. Sci. Hung., 29: 1-9(1961). (In English)

With respect to the fact that uranium ores are leached at higher temperatures with sodium carbonate, the possibility of ion exchange during or after leaching was investigated. The changes in the properties of the resins Mykion PA and Amberlite IRA-400 were examined at various temperatures. The capacity of resins was determined at 10° intervals from 20 to 90°C, and changes in this capacity were plotted against the number of leaching cycles. Also, the elution curves of the resins were established at various temperatures. (auth)

33058 THE MECHANISM OF THE NEGATIVE EFFECT OF OXYGEN-CONTAINING URANIUM COMPOUNDS ON THE COURSE OF THE METALLOTHERMIC REDUCTION OF URANIUM TETRAFLUORIDE; EXPERIMENTAL RESULTS. F. G. Reshetnikov and M. G. Gurvich. At. Energ. (USSR), 13: 54-8(July 1962). (In Russian)

Several factors, such as bulk weight, volatile admixture, oxyhalide content, etc. affect the reaction mechanism of the reduction of UF_4 by Ca or Mg. The presence of O-containing materials, especially of UO_2 and UO_2F_2 was found to reduce the U yield from 97 to 98 to 86% while causing the formation of a heavy slag. Although the CaO formed by the reduction of these compounds increases the melting point and the viscosity of the slag, its presence cannot account for the lowering of the U yield. This phenomenon is explained by pointing out the possibility of forming "secondary" UO_2 according to the equation $UF_4 + 2CaO \rightarrow UO_2 + 2CaF_2 + 103$ kcal. The change of the free energy of this reaction is practically independent from the temperature; thus a strong interaction between UF_4 and CaO takes place in the molten slag. The resulting secondary UO_2 is only very slightly soluble in the CaF_2, therefore the dissolved Ca reduces primarily the UF_4 in view of its higher solubility in the molten slag. Thermal analysis indicated 2 exothermic reactions, at 200 and at 600°C, in the UF_4 + CaO mixture: $UF_4 + CaO \rightarrow UOF_2 + CaF_2$; $UOF_2 + CaO \rightarrow UO_2 + CaF_2$. Similar observations were made with Mg as reducing agent. These considerations explain the negative effect of O-containing materials on the U yield. (TTT)

33059 CHARACTERISTICS OF THE DISSOLUTION PROCESS OF URANINITE WITH SULFURIC ACID CON-

TAINING OXIDIZING AGENTS. G. M. Alkhazashvili and G. M. Nesmeyanova. At. Energ. (USSR), 13: 170-7(Aug. 1962). (In Russian)

Following up previous studies on the oxidation of U in acid medium (Atomnaya Energiya, 8: 330 (1960) No. 4; 11: 456 (1961) No. 5) and on the catalytic influence of the transition metals, the dissolution of pure U compounds and of various pitchblende specimens was investigated in order to clarify the extraction mechanism of U from its ores. The samples included added Fe or Mn or both together with U at various oxidation levels. In some cases MnO_2 or HNO_3 were added to the H_2SO_4 as oxidizing agents. It was found that the ease of leaching out the U depends greatly on the chemical and mineralogical composition of the ore. Addition of ferric oxide reduced the time necessary for the extraction of U, especially in the presence of MnO_2; addition of HNO_3 slowed down the leaching process. If the ore does not contain Fe_2O_3 and MnO_2 their addition is beneficial, making it possible to extract the U at a faster rate and using weaker sulfuric acid solutions. (TTT)

33060 SYNTHESIS OF UO_2 BY THE REDUCTION OF HEXAVALENT URANIUM WITH ELEMENTARY SULFUR UNDER HYDROTHERMAL CONDITIONS. R. P. Rafal'skii, A. D. Vlasov, and K. F. Kudinova. At. Energ. (USSR), 13: 181-3(Aug. 1962). (In Russian)

Uranium dioxide may be prepared by the reduction of hexavalent U in acid medium by H_2, H_2S, FeO, and other reducing agents; at elevated temperatures and pressures, aqueous solutions of U(VI) may be reduced by SO_2 and elementary S. This reaction was further studied, carrying out the reduction of UO_2SO_4 solutions by S vapors in a quartz container the design of which prevented direct contact of the S powder and the solution. After heating the container to a temperature between 200 and 360°C for periods ranging from 1 to 70 hours in an autoclave, the latter was quenched in cold water and the reaction products were separated. At a molar ratio of 1:1 and heating the container to 360°C for a soaking period of 20 hours or more, all the hexavalent U was reduced to UO_2. During the first stages of the reaction intermediate oxides were obtained which were transformed into UO_2 upon extended heating. At an S/U ratio of 1:3, lower oxides with traces of UO_2 were obtained even at the highest experimental temperature. The lattice constants of the UO_2 were found to be high: 5.45 to 5.46 Å; the O coefficient was 2.16. The elementary S deposited on the crystal can be easily removed by organic solvents or heating in vacuum. (TTT)

Separation Processes

Refer also to abstract 32889.

33061 (AAEC/E-93) THE REPROCESSING OF HOMOGENEOUS BERYLLIUM-BASED REACTOR FUEL. A SUGGESTED SCHEME FOR THE SELECTIVE AQUEOUS DISSOLUTION OF THE MATRIX. M. S. Farrell and R. B. Temple (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Aug. 1962. 29p.

The matrix of a dilute homogeneous H.T.G.C. reactor fuel employing metallic Be as a moderator can be selectively dissolved by a caustic soda solution containing salicylate ion. At least 90% of the U and Th can be recovered as insoluble solids, but in the case of irradiated material the U loss might be higher. Some decontamination of the resulting Be solution from fission products and Pa^{233} can also be obtained. A tentative chemical flowsheet is proposed on the basis of the results obtained. (auth)

33062 (AAEC/TM-146) THE REPROCESSING OF BERYLLIUM-BASED REACTOR FUELS. A CHEMICAL FEASIBILITY STUDY OF A MODIFIED THOREX PROCESS FOR THE RECOVERY OF THE URANIUM AND THORIUM. M. S. Farrell, B. J. Orrock, and R. B. Temple (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Aug. 1962. 12p.

Stable solutions of basic beryllium nitrate can be formed with Be concentrations up to 9M, and an NO_3/Be mole ratio as low as 1:1. The efficiency of basic beryllium nitrate as an agent for salting-out U into a tributylphosphate/kerosene solvent was compared with that of other salts. It appears possible to separate U and Th from Be and fission products using a modified Thorex process in which beryllium nitrate replaces aluminum nitrate. (auth)

33063 (AERE-M-1064) THE STRIPPING OF URANIUM AND PLUTONIUM FROM DEGRADED TBP/OK. J. Kennedy (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Aug. 1962. 11p.

Alkaline peroxide, i.e., solutions of Na_2CO_3/H_2O_2 and $NaOH/H_2O_2$, give higher stripping rates for U from TBP in degraded hydrocarbon diluents than solutions of Na_2CO_3 alone. Pu(IV) is only partially stripped from the same system with alkaline H_2O_2 or Na_2O_2, but complete removal of Pu is effected with a reducing strip consisting of 0.01M uranous ion in 0.3M HNO_3. (auth)

33064 (BNL-752) AN EVALUATION OF MATERIALS OF CONSTRUCTION FOR THE SULFLEX AND ZIRFLEX PROCESSES. Herbert Katz and Robert Isler (Brookhaven National Lab., Upton, N. Y.). Aug. 1962. Contract [AT(30-2)-Gen-16]. 48p.

The corrosion resistance of potential materials of construction for both the Sulfex and Zirflex processes was studied. The results indicate that Ni-o-nel is a satisfactory material for the Sulfex process provided the sulfuric acid concentration is not greater than four molar and the nitric acid greater than five molar. In addition, core dissolutions should be done below the boiling point, and heat transfer surface temperatures during core dissolution should be maintained below 240°F. Carpenter 20 is probably less satisfactory for Sulfex service because of selective weld attack. Neither Ni-o-nel, 309 SCb, or 304L is a satisfactory construction material for uninhibited Zirflex solutions. Cupric ion lowers the corrosion rate of 309 SCb to 30–40 mils per year, but is not a satisfactory inhibitor for 304L or Ni-o-nel. (auth)

33065 (CEA-2180) THEORIE DE LA SEPARATION D'UN MELANGE GAZEUX PAR DIFFUSION A TRAVERS UNE PAROI POREUSE (theses). (Theory of the Separation of a Gaseous Mixture by Diffusion Through a Porous Wall (thesis)). Jean-Paul Breton (France. Commissariat a l'Énergie Atomique. Centre d'Etudes Nucléaires, Saclay). 1962. 75p.

Submitted to Université of Paris.

The previous theories of separation by gaseous diffusion (Present and de Bethune, Kynch, Bosanquet) were all based on the same model in which the pores are cylindrical capillaries. In the theory presented this model is substituted for by that of a disordered and isotropic bed of identical spheres, which describes more accurately most of the porous media. As the starting point Deriaguine and Bakanov's permeability theory, which expresses the flow of a simple gas in such a bed when the latter is of high porosity, was used. This theory was generalized in the case of

medium and low porosities; then a mixture of two gases was considered from which the separation theory was deduced. Results were compared with those of Present and de Bethune. (auth)

33066 (HW-SA-2636) CATALYTIC INCREASE IN DISSOLUTION RATE OF URANIUM OXIDES BY Cl_2 IN MOLTEN SALTS. M. C. Lambert and R. L. Braun (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [June 11, 1962]. Contract AT(45-1)-1350. 9p.

The dissolution rates of uranium oxides in molten chlorides are reported, and TiCl-catalyst-induced dissolution rate increases are discussed. (J.R.D.)

33067 (LADC-5424) THE PROCESSING OF PLUTONIUM BY ION EXCHANGE. II. THE ANION-EXCHANGE SEPARATION OF PLUTONIUM AND THORIUM. D. B. James and E. L. Christensen (Los Alamos Scientific Lab., N. Mex.). Mar. 18, 1963. Contract [W-7405-eng-36]. 6p.

A method for separation of Pu and Th on a plant scale using anion exchange from HCl solution is described. Data on effects of Pu and HCl concentrations, and a plant-scale flowhseet are included. (J.R.D.)

33068 (NAA-SR-6405) LIQUID LITHIUM EXTRACTION OF THORIUM FROM THORIUM–MAGNESIUM ALLOY. L. A. Hanson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 15, 1962. Contract AT-11-1-GEN-8. 16p.

A process for recovering Th from Th–Mg alloy, utilizing liquid Li extraction, was investigated. Dissolution of Th–Mg alloy in liquid Li metal resulted in the formation of a Li–Mg alloy solution and the precipitation of Th as a finely divided solid. Th separation was accomplished by filtration through stainless steel filters. Over 99.7% of the introduced Th was recovered in the precipitated residue. The concentration and final consolidation of separated Th was briefly studied. (auth)

33069 (ORNL-3298) RECOVERY OF PuF_6 BY FLUORINATION OF FUSED FLUORIDE SALTS. G. I. Cathers and R. L. Jolley (Oak Ridge National Lab., Tenn.). Oct. 8, 1962. Contract W-7405-eng-26. 15p.

Fused salt fluorination tests were conducted at 600°C to determine the feasibility of recovering plutonium as PuF_6 in the fused salt-fluoride volatility process. Recoveries and material balances were good, although the initial plutonium concentration in 50-50 mole % NaF – ZrF_4 or 31-24-45 mole % LiF–NaF–ZrF_4 salt was only 2 ppm. The volatilization reaction appeared to be approximately first-order with respect to the plutonium concentration in the salt. Results of absorption of the volatilization PuF_6 on beds of LiF, CaF_2, or NaF indicate that this is a possible method of trapping the material in fluoride volatility processes, possibly separately from UF_6. (auth)

33070 (ORNL-TM-297) CHEMICAL TECHNOLOGY DIVISION UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT, MAY 1962. M. E. Whatley, P. A. Haas, R. W. Horton, A. D. Ryon, J. C. Suddath, and C. D. Watson (Oak Ridge National Lab., Tenn.). Oct. 9, 1962. Contract [W-7405-eng-26]. 46p.

Foam separation HTU_x values for stripping Sr-89 from a dodecylbenzene-sulfonate solution to the surface of a foam were determined to range from 0.5 to 8 cm. Particle size measurements on pieces of porcelain filled ORNL Mark I prototype fuel elements chopped with the 250 ton shear along with visual comparisons showed that an optimum length of cut would be about $^9/_{16}$ in. Flow capacity data for sieve plate pulsed columns were obtained using two versions of the BNL-DSBPP flowsheet. Small scale pulsed columns were tested for extraction of nickel as a stand-in for Am and Cm from 11 M LiCl by 30% Alamine 336 in diethylbenzene. Twenty-three protective coatings of phenolics, epoxies, and vinyls are being exposed to a gamma flux of 10^6 rad/hr. Analysis is presented on the controller performance in the waste calcination development facility. (auth)

33071 (EURAEC-337) REPROCESSING OF IRRADIATED FUELS. Quarterly Report No. 4 (2nd year) January–March 1962. (Brussels. Centre d'Etude de l'Energie Nucleaire). Work performed under United States–Euratom Joint Research and Development Program. Contract 049-61-4-RDB. 42p. A translation.

Chlorination of uranium, zirconium, and niobium oxides by CCl_4 entrained by CO_2 enables the corresponding chlorides to be obtained rapidly and quantitively, without the formation of a carbon deposit. The use of CO to reduce U_3O_8 avoids the release of humidity which is detrimental to chlorination operations. A comparative study of reduction by H_2 and by CO is made. Various chlorination tests, in the presence of alkaline and alkaline-earth chlorides, were made to improve the separation of uranium and fission products. Transformation of UCl_{5-6} and UCl_5 into fluorides under the action of HF and SF_4 indicates that UF_6 and UF_4 are the products of the reactions with UCl_{5-6} and UCl_4, respectively. A thermogravimetrical study was made on the rate of hydrofluorination of UO_2 re-oxidized on the surface and then reduced again. An appreciable increase in the hydrofluorination rate was observed. The activation energy of this reaction attains about 8.7 kcal. Studies on uranium carbide hydrofluorination confirmed the existence of two concurrent actions in both gaseous and liquid HF. In the liquid phase, the maximum methane percentage and the minimum percentage of heavy hydrocarbons are found near 50°C. The behavior of ruthenium and iodine was studied during UC, UO_2, and UF_4 oxidation reactions in UO_3. Iodine decontamination is relatively slight; it may be eliminated by UC hydrofluorination in UF_4. Depending on the initial product, 80 to 95% of the ruthenium is volatilized after 5 hours oxidation. The use of gas analyzers enabled the technological operations of UO_2 reduction and oxidation to be made under the most favorable conditions. Oxidation by air can be accomplished in 45–90 minutes at 450°C, using gas velocities of 40–50 cm/sec; it can also be achieved at very low gas velocities. Reduction is achieved in 90–120 minutes, towards 500°C, in a pulsed bed; the hydrogen concentration is 25% and the gas velocity is approximately 30 cm/sec. With a view to effecting UO_3 oxidations by nitric vapors at 375°C, corrosion studies on titanium, tantalum, Ni-o-nel, steel, and stainless steel were made. (auth)

33072 AN INVESTIGATION OF THE URANYL NITRATE–WATER–NITRIC ACID–TRIBUTYLPHOSPHATE (TBP) SYSTEM IN THE REGION OF THE SEPARATION OF INDIVIDUAL PHASES. A. V. Nikolaev and I. I. Yakovlev (Inst. of Inorganic Chemistry, Siberian Div. of the Academy of Sciences, USSR). Dokl. Akad. Nauk, SSSR, 145: 1064-7 (Aug. 11, 1962). (In Russian)

Data are given on the composition of the aqueous and organic phases in the system $UO_2(NO_3)_2$–TBP–HNO_3–H_2O. Distribution coefficients for HNO_3 and $UO_2(NO_3)_2$ at 22°C are also presented in tabular form. The data are also expressed in the form of a tetrahedron, whose apexes correspond to the pure components $UO_2(NO_3)_2$, HNO_3, TBP, and H_2O. The base of the tetrahedron shows the equilibrium aqueous solutions, and the distribution coefficient are also shown as isolines in the aqueous part of the system. The

faces of the tetrahedron indicate the four ternary systems, and the volume within the tetrahedron corresponds to the quaternary system. The surfaces are joined by fine lines to form conoids, and the volume within the coupled surface corresponds to the region, where there is a separation of phases. The diagram shows the regions for the formation of mixtures of complexes such as TBP · $2HNO_3$, $UO_2(NO_3)_2$ · 2TBP, and TBP · $2HNO_3$ + TBP · HNO_3 + $UO_2(NO_3)_2$ · 2TBP. (TTT).

33073 EXTRACTION OF RARE EARTHS FROM HYDROCHLORIC ACID SOLUTIONS. Yu. S. Kuznetsov, I. N. Plaksin, and N. A. Suvorovskaya. Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Met. i Toplivo, No. 4, 59-61(July-Aug. 1962). (In Russian)

Solvent extraction of La_2O_3 from hydrochloric acid by kerosene diluted di[2-ethylhexyl] phosphoric acid was studied. The extraction depends on the hydrochloric acid concentration. 100% extraction was achieved with 0.03N HCl; at 0.15N HCl extraction was 52%. (R.V.J.)

33074 TRIBUTYL PHOSPHATE EXTRACTION OF ZIRCONIUM AND HAFNIUM. S. S. Korovin, E. N. Lebedeva, A. M. Reznik, L. N. Komissarova, and G. P. Kuznetsova. Izvest. Vysshikh Ucheb. Zavedenii, Khim. i Khim. Tekhnol., 5: 231-5(1962).

The distribution of Zr and Hf between 6N nitric acid and tributyl phosphate (TBP) solutions is reported for varying metal ratios in the starting aqueous solution. The nitric acid solutions of Zr and Hf nitrates freshly prepared from the starting pure oxychlorides were shaken for 30 min with an equal volume of a 50 vol % TBP solution on o-xylene, at 20 ± 2°C in separatory funnels. The equilibrium concentrations in both phases, the distribution coefficient, α, and the separation factor, β, were calculated with a maximum error of 10% from a combination of gravimetric and spectroscopic data. Distribution curves of the total oxides indicated very rapid saturation of the organic phase when the concentration of the total oxides in the aqueous phase was increased. For equimolar concentrations in the aqueous phase, Hf concentration in the organic phase was ¼ to ⅕ that of Zr. An increase in the content of Hf in the mixture had a less depressing effect on Zr extraction than did an increase in Zr on Hf extraction. Beta was at a maximum at 40 to 60 g/l of the total oxides in the aqueous phase at equilibrium, the maximum β value varying from 20 (the highest) to 9 with an increase from 2.4 to 95.8% of HfO in the starting mixture. It was concluded that pure Hf can be produced by use of TBP extraction but with a much lower separation efficiency than in the case of Zr. (OTS)

33075 THE SEPARATION OF In, Sn AND Sb BY LIQUID-LIQUID EXTRACTION. N. Kosaric and G. Leliaert (Centre d'Etude de l'Energie Nucléaire, Mol, Belg.). Mikrochim. Acta, No. 5, 806-10(1961). (BLG-82). (In English)

The extraction behavior of In, Sn, and Sb in HI and HCl media was investigated and several separation procedures were developed. Removal of Sb(V) from Sn(IV) is accomplished by extraction of Sb(V) from 7 M HCl solution with isoamylacetate. Selective removal of Sn(IV) or In(III), or both, from Sb(V) is effected by extraction with benzene or isopropylether from HI solutions. The extractions are quite simple, rapid, and efficient and therefore useful in the study of short-lived fission products. (auth)

33076 RECOVERY OF ETHYLENEDIAMINETETRAACETIC ACID. V. V. Starostin, G. F. Silina, and A. A. Lanin. Zh. Prikl. Khim., 35: 1846-51(Aug. 1962). (In Russian)

An equation was derived for evaluating EDTA solubility in metal complex compounds. The highest recovery of EDTA from solution was achieved at pH = 1 to 1.2 with 3 g of rongalite per g of iron. The optimum time depended on the initial EDTA concentration. (R.V.J.)

33077 PROCESSING OF URANIUM-METAL-CONTAINING FUEL ELEMENTS. Raymond H. Moore (to U. S. Atomic Energy Commission). U. S. Patent 3,057,717. Oct. 9, 1962.

A process is given for recovering uranium from neutron-bombarded uranium–aluminum alloys. The alloy is dissolved in an aluminum halide–alkali metal halide mixture in which the halide is a mixture of chloride and bromide, the aluminum halide is present in about stoichiometric quantity as to uranium and fission products and the alkali metal halide in a predominant quantity; the uranium- and electropositive fission-products-containing salt phase is separated from the electronegative-containing metal phase; more aluminum halide is added to the salt phase to obtain equimolarity as to the alkali metal halide; adding an excess of aluminum metal whereby uranium metal is formed and alloyed with the excess aluminum; and separating the uranium–aluminum alloy from the fission-products-containing salt phase. (AEC)

ENGINEERING AND EQUIPMENT

General and Miscellaneous

Refer also to abstracts 32625, 32903, 33996, and 33997.

33078 (ARF-3187-9) ELECTROSTATIC CLASSIFICATION OF SUBMICRON AIRBORNE PARTICLES. Progress Report, August 1 to October 1, 1962. G. Langer (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Contract AT(11-1)-578. 9p.

Developments are reported in the classification of submicron airborne particles by electrostatic means. Design features are described of a sampler to classify atmospheric dust particles at a rate approaching 1 cfm. Laboratory studies were carried out on the controlled charging of particles without undue aerosol losses and means of eliminating the interference due to the deposition of small and large particles in the same area. Performance tests were carried out on the charger and the high-volume classifier. Preliminary tests were made on the classification of atmospheric dust. (C.H.)

33079 (COO-1019) FACTORS IN AGGLOMERATION OF SOLID AEROSOL PARTICLES. Technical Report No. 17. Final Report. Kingsley Kay and H. F. Johnstone (Illinois. Univ., Urbana. Engineering Experiment Station). Sept. 1, 1962. Contract AT(11-1)-276. 45p.

A total of 24 one-component aerosol systems was studied to determine the comparative void space in agglomerates and the relationship of packing to the properties of the materials employed. From these experiments it was found that for 18 systems structural or unit form correlated roughly with void space, as estimated by the difference between $CD^3\rho$ determined experimentally and calculated for ideal spheres of the different materials at mass 1×10^{-12} gram. A few substances failed to sustain the correlation at high agglomerate masses of 1×10^{-11} gram. Spherical units produced agglomerates with least void space, and substances of isometric structure had agglomerates with the highest void space. Delineation of structure-related factors playing a direct role in these phenomena was not made. For systems which did not appear to correlate structurally or in terms of unit form it was possible to describe special characteristics not obviously structure-related which can act to influence packing or produce simulated effects. It is evident from this study that many substances will occur in the air as agglomerates having diameters substantially higher in relation to mass than the density of the pure substances would dictate. Experimental findings suggest that further research might make it possible to propose that packing characteristics may be predictable by considering unit form or structure. Such considerations could have practical application in the collection of aerosols by filtration. Another possible application would be the treatment of material to convert to another structural form having different packing prospects in agglomeration. (auth)

33080 (NP-12125) AN ANNOTATED BIBLIOGRAPHY ON LABORATORY BUILDINGS. Bibliography No. 16. A. Brass, comp. (National Research Council of Canada. Div. of Building Research, Ottawa). June 1959. 17p.

A bibliography of selected references on design of laboratory buildings is presented. Comment concerning the information presented is included for part of the listings. A total of 95 references is included. (J.R.D.)

33081 (TID-16698) PRECISE PRESSURE CONTROL. E. C. Hutchison (Oak Ridge Gaseous Diffusion Plant, Tenn.). [nd.] Contract [W-7405-eng-26]. 20p.

Precise control of pressure is essential for maintaining steady conditions in wind tunnel processes and test facilities. An automatic control system, composed of standard pneumatic instruments, that can maintain the pressure in a flowing air stream to within 0.02 per cent of set conditions, while overcoming load changes of as much as 1 per cent in the incoming pressure is described. (auth)

33082 (UCRL-6958-T) PERFORMANCE OF A SIX-INCH TRIODE P.I.G. PUMP COMPARED TO A 'PERFECT' PUMP. Norman Milleron and Finn S. Reinath (California. Univ., Livermore. Lawrence Radiation Lab.). Aug. 23, 1962. Contract [W-7405-eng-48]. 16p.

Operational characteristics of a commercial P.I.G. (ionic) pump are discussed and measured with reference to volumetric speed, backward flow (including regurgitation of pumped gases), and usable life. These properties are distinguished from chamber wall effects by comparing the performance of each of two pumps on the same chamber. First a P.I.G. pump is used, then a diffusion pump system. Cylinder grade N_2, He, and H_2 gases are admitted to establish both steady state and transient pressure conditions. Results show that P.I.G. pump speed varies from an almost zero speed up to above the manufacturer's rating, depending on the pump's history, the pressure range, and the type of gas. (auth)

33083 (UCRL-6963-T) PROGRESS ON OPTIMIZATION OF OIL DIFFUSION PUMP SYSTEMS FOR ULTRA-HIGH VACUUM. IV. Norman Milleron and Leonard L. Levenson (California. Univ., Livermore. Lawrence Radiation Lab.). Aug. 27, 1962. Contract [W-7405-eng-48]. 6p.

A discussion of oil cracking by the ribbon heating element and by the jet stack surfaces is given. Relations of mass transfer and divergence in oil jets to gas entrainment efficiency are touched on. An all stainless steel 100 lb/linear in. valve closure, which is bakeable to 400°C in the closed position against air, seals with less than 10^{-9} cc He/sec leakage, and closes in $< \frac{1}{8}$ second, is described. An all stainless steel, inflatable ring-type bladder seal is also described. (auth)

33084 CHEMICAL-THERMIONIC AUXILIARY POWER SYSTEMS. C. V. Burkland (Marquardt Corp., Van Nuys, Calif.). Applications and Ind., No. 61, 193-6(July 1962).

An analysis of the problems of matching the performance of a high-temperature plasma-thermionic static-energy conversion device to a heat source consisting of the combustion products of chemical fuels is presented. The thermodynamic relationships governing the efficiency and power densities of the thermionic converter as a function of cathode temperature and work function are established and the limitations imposed by positive ion space charge neutralization are pointed out. The temperature and heat flux limits set by the heat source are compared to the converter requirements and various matching problems are discussed. It is concluded that a chemical-thermionic power system is a promising concept as a source of electric power, in amounts ranging from watts to megawatts (Mw), for a number of aerospace applications that require a reliable, lightweight, compact converter and an available, economical, easily handled heat source. (auth)

33085 DESIGN FOR A NUCLEAR-POWERED WATER RAMJET. Gerald Rosen (Martin Marietta Corp., Baltimore). ARS (Am. Rocket Soc.) J., 32: 1403-4(Sept. 1962).

The design of a nuclear-powered water ramjet for the propulsion of a hydrofoil vessel is analyzed. Losses due to mechanical dissipation and heat transfer are not considered. The analysis is applied to a ramjet with a net thrust of 10^6 lb and a cruising speed of 150 fps, and a reactor net power of 67.1 Mw is found to be required. (D.L.C.)

33086 SPATIAL NONUNIFORMITY EFFECTS IN ELECTROTHERMAL PROPULSION. A. Mironer (Allied Research Associates, Inc., Boston) and H. Macomber. ARS (Am. Rocket Soc.) J., 32: 1412-13(Sept. 1962).

In the presently operated electrothermal propulsion engines, only a fraction of the total gas flow passes through the electrical discharge volume. This spatial nonuniformity in the flow is shown to cause a decrease in engine efficiency at the lower values of average gas enthalpy; at higher values of average gas enthalpy, this effect is shown to increase engine performance. These analytical results are in qualitative agreement with experiment. (auth)

33087 ELECTROMAGNETIC PHENOMENA IN FLAT-TYPE INDUCTION PUMPS FOR MOLTEN METAL. N. M. Okhremenko. ARS (Am. Rocket Soc.) J., 32: 1442-8(Sept. 1962).

The significant features of electromagnetic pumps of the flat-linear type are outlined, and the electromagnetic phenomena in these pumps are generalized. Longitudinal and transverse fringe effects are considered as well as the demagnetizing effect of currents in the metal. A comparison of computed pressures and powers with experimental values is given. (D.L.C.)

33088 POWER SUPPLIES FOR SPACE VEHICLES. K. E. V. Willis (National Research Development Corp., London). J. Brit. Inst. Radio Engrs., 22: 179-88(Sept. 1961).

The requirements for electrical power in space vehicles over the next five years are reviewed and estimated figures given with particular reference to power/weight ratio. Vehicle life duration and its effect on choice of supply are discussed. Problems encountered in space vehicles due to environmental conditions, e.g., temperature, radiation, zero gravity, etc., are then pointed out. The available generation methods are: thermoelectric generators; thermionic converters; the fuel cell; solar energy nuclear sources; magnetohydrodynamic methods. (auth)

33089 A TRANSISTOR THERMOCOUPLE TRIP AMPLIFIER. G. G. Ballard (Elliott Nucleonics Ltd., London). J. Brit. Inst. Radio Engrs., 23: 35-40(Jan. 1962).

The problem of protecting a nuclear reactor against excess temperature operation is reviewed and design requirements applicable to thermocouple trip amplifiers are discussed. Particular mention is made of features which render the unit fail-safe. It is concluded that a unit possessing the necessary fail-to-safety features may be manufactured using transistor techniques. The equipment may be made both reliable and compact and these features, supported by robust construction, fulfil the needs of first-line temperature protection on a nuclear power reactor. (auth)

33090 THE TANDEM VAN DE GRAAFF ACCELERATOR AT LIVERPOOL UNIVERSITY. B. S. Halliday (Univ. of Liverpool). J. Inst. Elec. Engrs. (London), 8: 284-7 (June 1962).

A tandem Van de Graaff accelerator using the charge-exchange theory has been installed. It will be used to investigate nuclei excited by high-energy protons and deuterons. Energies up to 12 Mev are expected. The underlying principles and construction of the accelerator are described. (auth)

33091 NEW PROTECTIVE SUITS AGAINST RADIOACTIVE CONTAMINATION. A. Meixner. Kerntechnik, 4: 387-90(Sept. 1962). (In German)

A new protective suit against radioactive contamination is described which allows working in contaminated environs, in presence of radioactive aerosols or gases. In contrast to a former described one the suit is not fireproof, and therefore it is not fit for fight against fire. But it is lightweight, cheap, and easy producible in large quantities. Further there is described a protective working suit to wear in radiochemical laboratories. It saves the clothing of the wearer from radioactive contamination. (auth)

33092 THE LAUNDRY OF A NUCLEAR RESEARCH CENTRE. A. Meixner. Kerntechnik, 4: 391-3(Sept. 1962). (In German)

The special demands on the laundry of a nuclear research center are described. By the example of cleaning and ironing in two days the radioactive contaminated work clothing of a staff of 1200 coworkers, a detailed plan is given for the construction of a serviceable laundry and an exact description of the flow sheet is added. (auth)

33093 CONTAMINATION OF LABORATORY GLASSWARE, ITS PREVENTION AND REMOVAL. B. Marchand (Universität, Freiburg i. B.). Kerntechnik, 4: 394-7(Sept. 1962). (In German)

The significance of contamination of laboratory glassware used in the course of scientific experiments is discussed. Some examples show possibilities for the prevention and the removal of contamination of glass instruments. (auth)

33094 PUMPS FOR DELIVERY OF HOT RADIOACTIVE CONTAMINATED ORGANIC LIQUIDS. H. Backs (Euratom, Brussels). Kerntechnik, 4: 398-401(Sept. 1962). (In German)

A survey is given of the stage of development attained with pumps which can be employed for the transfer of hot radioactive contaminated organic liquids, reference being made to certain problems occurring in operation. A brief description of the various types of pumps is given together with a comparison of their characteristics. (auth)

33095 SHIPPING CASK FOR IRRADIATED FUEL ELEMENTS. W. Geipel. Kerntechnik, 4: 402-10(Sept. 1962). (In German)

Aspects to be considered for the construction of shipping casks are given. Owing to the lack of German construction regulations, experiences gained in the construction of the shipping cask for the first German nuclear power plant at Kahl (Main) according to regulations published by the USAEC are reported. (auth)

33096 DECONTAMINATION OF HOSPITAL WASTE WATERS. H. Mende. Kerntechnik, 4: 410-14(Sept. 1962). (In German)

In the radiological wards of hospitals, more or less contaminated laboratory and rinsing waters and human waste from the patients' toilets are produced. Various possibilities for storage and break-down installations are discussed with their advantages and disadvantages. An installation planned appropriately for the prevailing requirements guarantees that the legal provisions for keeping the water clean can be adhered to safely. (auth)

33097 DECONTAMINATION BY MEANS OF ULTRASONICS. W. Lehfeldt. Kerntechnik, 4: 415-16(Sept. 1962). (In German)

The long experiences in ultrasonic cleaning of all types of machine parts and the appliances developed for this purpose, can be used without hesitation for the problem of decontaminating parts which are contaminated. The construction and operation of this type of cleaning installations is described. The liquids used for cleaning are variable and depend on the type of dirt. For decontamination, several cascade connected baths are most suitable to have the liquid consumption as low as possible. This is important as the fluid will be contaminated especially in the ultrasonic bath. (auth)

33098 TYPES OF REACTORS CONSIDERED FROM CONTACTS OF REACTION ROUTES, APPLICATIONS TO NUCLEAR REACTOR AND FUEL CELL. Shoji Makishima (Tokyo Univ.), Sohachiro Hayakawa, Takeshi Tomotsu, and Keiji Naito. Kogyo Kagaku Zasshi, 64: 1741-4(1961). (In Japanese).

The possible types of reactors were discussed from the ways of contacts in various routes which were chosen along the flow of materials and energies in a reactor. A general mathematical treatment was given in counting the number of ways of contacts for n-route reactor, the basic ways of contact being three between any two routes, namely, homogeneous, heterogeneous and non-contact. The numbers of the ways of contacts, i.e., the types of reactor, were calculated as 2, 8, 70, and 1224 for 2, 3, 4 and 5-route reactors, respectively. These results were applied to nuclear reactors and fuel cells. There are 8 types for the simplest thermal nuclear reactors, which are composed of three routes, namely the nuclear fuel, the moderator and the coolant. When the blanket or reflector is added, or any of the three routes mentioned above are divided into two separate regions, the types increase rapidly, the reactor becoming four-route one. The fuel cells were treated as four-route reactor which consists of the four routes of fuel combustion, charge collection, electrode reaction and electrolytic conduction inside the cells. Several examples of the fuel cells were given. (auth)

33099 POWER SOURCE FOR NUCLEAR SPACE INSTRUMENTS. William R. Corliss (Martin Co., Baltimore, Md.). Nucleonics, 20: No. 10, 61-3(Oct. 1962).

It is expected that power supplies for space application will eventually become standardized and will probably be nuclear. The problems of integration of a power plant into a space vehicle are described. Tailored and standardized space vehicles are discussed. The characteristics of nonnuclear and nuclear power plants are tabulated. Possible improvements are discussed. (D.L.C.)

33100 VERSATILE ACCELERATOR FACILITY FOR RESEARCH AT RPI. V. Lawrence Parsegian (Rensselaer Polytechnic Inst., Troy, N. Y.). Nucleonics, 20: No. 10, 104; 106-7(Oct. 1962).

A description is given of a microwave electron linear accelerator which produces 35-Mev electrons at a peak power output of 135 Mw and an average power of 48 kw. Electrons are initially accelerated to 200 kv by a Cockcroft-Walton accelerator and injected into the main accelerator system. Specifications and measured pulse data are tabulated. The research program to be conducted with the accelerator is described. (D.L.C.)

33101 DIRECT CONVERSION. H. Malcolm Ogle (General Electric Co., Palo Alto, Calif.). Power Eng., 65: 57-66(Jan. 1961).

The limitations of present methods of power generation using mechanical energy as an intermediate are reviewed. The following methods of direct energy conversion are discussed together with the problems needed to be solved for their practical application: magnetohydrodynamics, thermoelectrics, gaseous thermoelectrics (plasma thermocouple), thermionics, photovoltaic cells, and fission fragment collection. The use of a reactor as heat source is considered. (D.L.C.)

33102 THIS MHD PLANT IS SIZED FOR UTILITY FEASIBILITY STUDIES. R. C. Allen. Power Eng., 66: 41-3(Aug. 1962).

A full-scale study was made on a 300-Mw(e) coal-burning magnetohydrodynamic plant. Fuel and oxidant are fed into a combustion chamber, and some potassium seed is added to the combustion gas, which is then expanded through a nozzle between the poles of a d-c magnet. The components of the plant are described in some detail. (D.L.C.)

33103 FULL-SCALE MHD PLANT FOR UTILITY FEASIBILITY STUDIES. R. C. Allen. Power Eng., 66: 59-61(Sept. 1962).

The problem of converting the d-c to a-c in the 300-Mw(e) magnetohydrodynamic coal-fired plant is considered. A combination of a plurality of current-collecting electrodes and separate motor-generator components probably will be used. A temperature-entropy diagram for the operating cycle and estimated heat rates are given. Problems and needed data for the development of MHD power generation are discussed. (D.L.C.)

33104 MOVING EARTH AND ROCK WITH A NUCLEAR DEVICE. John S. Kelly (U. S. Atomic Energy Commission, Washington, D. C.). Science, 138: 50-1(Oct. 5, 1962).

The results of Project Sedan, a successful cratering experiment, are summarized. A 100-kt thermonuclear device was exploded on July 6, 1962, at a depth of 635 ft in alluvium. The resulting crater has a maximum depth of ~320 ft and an average diameter of ~1200 ft, indicating that the crater diameter depends on the 0.25 power and depth on the 0.3 power of the yield in the 100-kt yield range. The fallout and ground shock are discussed. (D.L.C.)

33105 EXTREME-TEMPERATURE BEARING DEVELOPMENT — 1600 F. R. H. Bradley (Boeing Co., Seattle). Preprint Paper No. 62-Lub-12. Prepublication Copy. 8p. $1.00.

The development of antifriction airframe bearings for use at 1600°F is described. The development is traced from the initial materials screening effort through a "development bearing" phase and finally to successful evaluation of full-scale production bearings. Data reported include load, friction, and life characteristics of experimental extreme temperature ball bearings. Results of associated raceway conformity and vibration testing are presented. Test of the final configuration demonstrated that titanium-carbide-cermet ball bearings will adequately perform at 1600°F for short time periods at load levels up to 2250 nd^2. (auth)

33106 THE MAGNETOHYDRODYNAMIC JOURNAL BEARING. Dennis C. Kuzma (General Motors Corp., Warren, Mich.). Preprint Paper No. 62-Lub-16. Prepublication Copy. 4p. $1.00.

An analysis of an infinite journal bearing is presented for the case of an electrically conducting fluid in the presence of a magnetic field. The magnetohydrodynamic form of Reynolds' bearing equation is derived and solved for the pressure distribution. The load carrying capacity is determined from the pressure distribution. Numerical data are presented for nonconducting bearing surfaces. These data are compared with the data from the ordinary journal bearing. It is shown that the load carrying capacity is increased by the application of a magnetic field. (auth)

33107 REMOVABLE SEALING DEVICES. (to United Kingdom Atomic Energy Authority). French Patent 867,127. Sept. 19, 1960.

In gas-cooled reactors it is necessary to provide reliable sealing means for the refueling apertures in the pressure vessel. These sealing means, besides preventing coolant leakage, must be readily withdrawable to allow unhindered refueling operations. Thus, this removable sealing device comprises a removable sealing member for the aperture, a sealing member thrust structure, and a series of struts acting between the structure and sealing region of the member. At least one of the struts is extensible to create a thrust acting equally on other struts in the series. The means for distributing the thrust comprises a ring of rocking members alternately of arched and inverted arch form capable of rocking on the struts and sealing members. The members of arched form are rockable on their adjacent members of inverted arch form. Each extensible strut is screwed in an internally screwed member and there are means for effecting relative rotation between the two members. This means has external gear teeth adapted to engage with the teeth of a gear wheel so that rotation of the gear wheel effects relative rotation between the two members. (NPO)

33108 GAS TIGHT SEAL FOR A HIGH SPEED ROTARY SHAFT. (to Reactor Centrum Nederland). French Patent 1,213,459. Apr. 1, 1960.

A gas tight seal for a high speed shaft, e.g., the shaft of a turbine, a compressor, or an ultra-centrifugal machine, comprises a housing with a boring through which the driving shaft passes. The inner surface of the boring or the outer surface of the shaft is provided with two oppositely wound spiral grooves. At least one annular groove is arranged between the spiral grooves. The spiral grooves are wound in directions such as to ensure transport of gas away from the annular groove when the shaft rotates in normal direction. (NPO)

33109 VALVES FOR NUCLEAR POWER PLANTS. A. Huet. French Patent 1,235,551. May 30, 1960.

The hot coolant coming from a reactor passes through a series of individual parallel boiler elements delivering steam into a common header. The disposition is such that one of several boiler elements may be withdrawn from the installation without stopping the operation. Valves are situated in the connecting lines from the reactor. To ensure fluid tightness at any temperature, cooling circuits are provided at both sides of each valve casing and inside the closure pieces of the valves. For withdrawal one of the valves is closed and a non-radioactive fluid is injected into the element via a special opening to eliminate any radioactive fluid from the element. (NPO)

33110 CONTAINERS FOR NUCLEAR REACTORS OR SIMILAR APPARATUS. (to Nordisk Reaktor Selskab a/s). French Patent 1,242,466. Aug. 22, 1960.

This pressure container comprises a plurality of relatively thin shells for easier handling, transport, and welding. The shells are concentrically placed, adjacent shells being spaced. The spaces bounded by adjacent shells are filled with an incompressible liquid to ensure uniform pressure transmission from shell to shell. Each shell is gas-tight so that a fissure in a shell may be detected by checking the pressures in the spaces. The liquid contains fused lead which enters fissures and ensures tightness by solidifying. The liquid may also be used for removing the heat developed by radiation absorption in the shells or for the control of the nuclear chain reaction of a reactor. In the latter case the liquid may be a fissile material or may have significant neutron moderating or absorbing properties. (NPO)

33111 TELEVISION CAMERA EQUIPMENT FOR INACCESSIBLE LOCATIONS. (to AEI-John Thompson Nuclear Energy Co. Ltd.). French Patent 1,248,876. Nov. 14, 1960.

Television camera inspection equipment for inaccessible locations in reactors in which the inspection equipment is carried on the end of a hollow supporting hose is described. Means are provided for effecting a forward flow of coolant gas through the hose and television camera and a return flow through an outer path which extends around the camera. The equipment is adapted for reactor fuel channels in which the supporting hose is carried on a winding drum located in an auxiliary pressure vessel coupled to the reactor pressure vessel. The outer return flow exhausts at or near the camera, while according to another embodiment the supporting hose has concentric passages, the forward flow passing along the inner passage and the return flow along the outer passage, whereby connections are provided at the drum so that the return flow is passed through cooling apparatus and a blower and then recirculated through the inner passage of the hose. (NPO)

33112 CENTRIFUGAL PUMP INSTALLATION FOR THE SAMPLING OF RADIOACTIVE LIQUIDS. (to United Kingdom Atomic Energy Authority). French Patent 1,248,341. Oct. 31, 1960.

A radioactive liquid flows through a duct in a shielded space which is provided with a sampling system. The sampling system comprises a centrifugal pump in a preferably vertical cylindrical casing. The pump is dipped into the liquid while the vertical driving shaft with air lubricated hydrostatic bearings is driven by an air turbine. The pump inlet communicates via lateral openings in the pump casing with the liquid in the cylindrical casing, while the exit line of the pump and the air supply lines for the turbine and the bearings pass through the shielding. The pump is removable from the cylindrical casing via an opening accessible from outside the shielding. (NPO)

33113 INSTALLATION FOR THE AUTOMATIC STARTING OF A STANDBY INTERNAL COMBUSTION ENGINE FOR NUCLEAR POWER PLANTS. (to United Kingdom Atomic Energy Authority). French Patent 1,260,312. Mar. 27, 1961.

In order to ensure an available electric power in the case of the breakdown of the main power, an internal combustion engine is provided for driving a standby generator. A relay releases and causes a movable latch to open a valve of pressurized air for starting by a rotating distributor the pistons of the internal combustion engine. The valve is closed by the increasing pressure of the engine lubrication fluid, this pressure acting on a piston connected with the closure means of the valve. The closure means is locked in the closed position of the valve and is only able to be unlocked by the latch. (NPO)

33114 PRESSURE VESSEL FOR A NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,263,532. May 2, 1961.

A reactor pressure vessel comprises principal and secondary wall sections in the form of a segment of a sphere, the second wall being thicker than the principal section and having a smaller radius, and an intermediate section connecting these two sections. The second wall section is perforated in order to form a network of holes for access into the vessel. (NPO)

33115 REMOVABLE PIPE CONNECTION. (to Beteiligungsund Patent Verwaltungs H.m.b.H. and Brown, Boveri and Cie A. G.). French Patent 1,266,003. May 29, 1961.

Tubular ducts, formed by a tube enclosed by a sheathing ensuring the protection against radiation emitted by material within the tube, are provided with removable pipe connections each comprising flanges with an outer diameter greater than the diameter of the tube sheating. The flanges of the tube extremities to be joined are connected by screw bolts. These bolts are sufficiently remote from the radiation emitting material, so that no essential radiation reaches these bolts. The tubes themselves are connected by gas tight joints of the kind in which one part is provided with an annular rib engaging in a corresponding groove of the second part. A similar joint with a broader rib and the former joint prevent any radiation escape at this place. At the level of such a joint, the duct is enclosed by a supplementary casing which is filled with a protection fluid, preferably a noble gas, at a pressure higher than the fluid pressure in the duct. (NPO)

33116 COVER FOR THE PRESSURE VESSEL OF A NUCLEAR REACTOR. (to Commissariat a l'Énergie Atomique). French Patent 1,269,100. July 3, 1961.

A circular cover for a reactor pressure vessel comprises a thick circular central section having a diameter smaller than the diameter of the vessel and provided with access holes and a thick peripheral annular section fixed to the central section. The outer cylindrical surface of this annular section fits in the upper extremity of the pressure vessel wall. The upper extremity is inside provided with a square section annular groove so that locking means radially slidable within the annular section of the cover may engage this groove in order to lock the cover. (NPO)

33117 ATTACHMENTS OF BRANCH PIPES TO PRESSURE VESSELS FOR NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,270,970. July 24, 1961.

A pressure vessel penetrated by a branch pipe is characterized in that the axis of the cylindrical surface of contact between the branch pipe and vessel makes a greater branch angle with the tangential plane of the vessel at the point of attachment of the branch pipe to the vessel than that made by the axis of the bore of the branch pipe with the tangential plane. Suitably a first series of such branch pipes defines refueling apertures for the reactor core, while a second series of such branch pipes penetrates the upper portion of the pressure vessel, so that tie-rods may extend through the bores of this second series of branch pipes in order to support the reactor core within the vessel and the vessel itself. (NPO)

Heat Transfer and Fluid Flow

33118 (AAEC/E-92) AXIAL TEMPERATURE DISTRIBUTIONS IN CONCENTRIC COOLING CHANNELS SURROUNDING A HEAT GENERATING SOURCE. F. H. Carr (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). July 1962. 21p.

A set of simultaneous differential equations was established to describe the temperature distribution for coolant flow in three concentric channels separated by walls of finite thermal conductivity and surrounding a cylindrical heat source. The solution of this set of differential equations is dependent on the heat source function Q(z) which must be known or specified. An assumed function Q(z) = constant was taken as being a representative case and the resultant solutions were applied to several geometric arrangements. The system of three channel flow reduces to two channel flow when there is zero heat flow across the outer intermediate wall. This condition may arise if the wall is a perfect insulator, or if the flow in the third channel is zero. For the former case the temperature in the third channel is constant over its length, and in the second the stationary coolant assumes the temperature of the coolant in the middle channel. From the set of differential equations established for two channel flow, treatment similar to that used for three channel flow was adopted and the resultant solutions were applied to several geometric arrangements. Mention is made of single channel flow. By assuming that the heat source is zero in the case of two channel flow, expressions were derived for the temperature distribution in parallel flow heat exchangers. (auth)

33119 (AD-275147) INVESTIGATION OF LIQUID METAL BOILING HEAT TRANSFER. Quarterly Progress Report No. 2. Richard E. Balzhiser, Robert E. Barry, John A. Clark, C. Phillip Colver, William Myers, Andrew Padilla, and Lowell R. Smith (Michigan. Univ., Ann Arbor. Coll. of Engineering). Apr. 1962. Contract AF 33(616)-8277-Item-IIa. 28p. (ORA-04526-4P)

Progress is reported in modification and finalization of equipment design. Equipment specifications are near completion for each phase of the experimental program. K will be boiled in a forced circulation loop where quality and flow rate effects on the heat transfer coefficient will be studied. Pressure drop and void fraction measurements will be made in a second test section to learn more about two phase flow behavior with metallic fluids. A pool boiler will be used to study pressure effects and to increase the temperature and flux levels beyond the 1800°F and 10^6 Btu/hr-ft^2 anticipated in the loop. Film boiling of K will be studied using condensing Na or Li as a heat source. A Nb vessel will be used thus making it possible to increase the range of surface temperatures. Initial agravic experiments will utilize mercury pool boiling from a stainless surface with normal accelerations up to 20 g's. Fabrication of equipment is expected to begin during the next quarter. (auth)

33120 (APAE-122) TEST PROGRAM FOR 30 MEGAWATT PROTOTYPE SODIUM INTERMEDIATE HEAT EXCHANGER AND STEAM GENERATOR. (Alco Products, Inc., Schenectady, N. Y.). Sept. 14, 1962. Contract AT(11-1)-666. 85p.

The designer's concept of a test program for the 30-Mw prototype intermediate heat exchanger and steam generator designed and fabricated as part of the Sodium Components Development Program is presented. The performance data will serve to verify the thermal design, or allow application of improved techniques to future designs, give an improved basis for stress analysis in design of future units, and demonstrate the capability and limitations of the units in relation to the performance specifications for which they were designed. Welding techniques for type 316 stainless steel are described. The specifications and operating conditions of the units are given along with instrumentation drawings showing test equipment design and arrangement. (N.W.R.)

33121 (NAA-SR-Memo-7157) HEAT TRANSFER IN ORGANIC-COOLED REACTORS. T. T. Shimazaki, D. A. Huber, and K. L. Adler (Atomics International. Div. of

North American Aviation, Inc., Canoga Park, Calif.). June 29, 1962. Contract AT-11-1-GEN-8. 26p.

The heat transfer aspects of organic-cooled power reactors are discussed. Typical organic reactor coolants are described. Data on convective heat transfer, boiling heat transfer, and critical heat flux of some organic coolants are presented. Convective heat transfer coefficients and, if the volatilities of the various compounds in the coolant are not too different, boiling heat transfer rates are found to be predictable from generalized correlations. The critical heat flux of a polyphenyl mixture is found to increase with addition of high boilers. Heat transfer limitations due to pyrolytic and radiolytic decomposition effects are discussed. Thermal, heat transfer, and hydraulic data for a 300 Mwe organic moderated and cooled power reactor are given. The possibility of improving organic coolant heat transfer by use of additives and by other means is indicated. (auth)

33122 (NAA-SR-Memo-7393) SODIUM TRANSFER–HELIUM FLOW CIRCUIT. R. J. Walters (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 15, 1962. Contract [AT-11-1-GEN-8]. 11p.

Vaporization rates of sodium into the helium stream were estimated using the analogy between heat and mass transfer. Because of the high helium velocities existing in the fuel handling cask, essentially all of the sodium vaporized from the fuel element surfaces will be carried into the external circuit unless an entrainment separator is provided. Approximately one pound of sodium will be carried as mist and vapor from the cask during the initial 15 to 30 minutes of the fuel handling operation. The gas has a saturation capacity of 0.11 lb/hr of sodium. In the external heat exchanger, 0.11 lb/hr of mist will be formed. This sodium should not deposit on the tubes because of the high flow velocity. To protect the heat exchanger and the blower, cyclone separators or wire mesh demisters are recommended. (auth)

33123 (NAA-SR-Memo-7417) HYDRAULIC CHARACTERISTICS OF A SHIELD PLUG ORIFICE. C. P. Sutherland (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 23, 1962. Contract [AT-11-1-GEN-8]. 13p.

Measurements of the pressure-drop across the orifice of one of the shield-plug orifice assemblies to be used at HNPF indicated that: the core pressure drop required to yield the maximum predicted fuel element flow rate requirement of 22.5 lbs/sec is 11.0 psi; the temperature sensitivity of the orifice ranges from 75 to 160°F/in. over the full orifice stroke and is a maximum of 130°F/in. in the predicted adjustment range of 0.5 to 4.0 in. withdrawn. In all cases the flow rates for a given orifice position and pressure drop were within 1% of the average flow rates. In addition, the liquid level height in the upper plenum was found to have no influence on the flow rate for all plug positions from fully inserted to 3-in. withdrawn. For orifice positions of 3.5 and 4 in., flow into the upper plenum with a liquid level corresponding to 1000°F isothermal primary system was respectively 2.5 and 5% higher than flow into a plenum liquid corresponding to 345°F isothermal. The orifice plug can be manually adjusted to reposition (within 0.003 in.) over the entire 4-inches of plug travel. The torque required to adjust this orifice over the withdrawal stroke was found to vary between 6 and 16-in.-lbs and was constant at 2 in.-lbs when inserting the orifice plug. (auth)

33124 (TID-16451) BASIC EXPERIMENTAL STUDIES OF BOILING FLUID FLOW AND HEAT TRANSFER AT ELEVATED PRESSURES. Monthly Progress Report, July 1962. Bruce Matzner (Columbia Univ., New York. Engineering Research Labs.). July 31, 1962. Contract AT(30-3)-187. 22p. (MPR-XIII-7-62)

Work was carried out on the Dissolved Helium Annular Test Section. The subcooled burnout tests are described. Data were collected at 1000 psia for nominal inlet water velocities of 10, 15, and 20 ft/sec subcoolings of 5 to 125°F and no helium addition to the coolant. Some preliminary results were obtained at 1000 psia with helium dissolved in the coolant stream and at 500 psia with no helium addition. (auth)

33125 (TID-16750) A BOILING MODEL. D. E. Dougherty (Knolls Atomic Power Lab., Schenectady, N. Y.). Oct. 21, 1960. Contract [W-31-109-eng-52]. 14p.

The microscopic dynamics of the boiling process was formulated into a differential equation for use in determining the steam void fraction which prevails in boiling channels. Details of formulation development are included. (J.R.D.)

33126 (UNC-5021) A SURVEY OF COOLANT VAPORIZATION EFFECTS IMPORTANT TO FAST REACTOR SAFETY. Arthur J. Goldman (United Nuclear Corp. Development Div., White Plains, N. Y.). June 30, 1962. Contract AT(30-1)-2832. 54p.

The role of coolant vaporization phenomena of importance in fast reactor safety analysis is evaluated for the various abnormal operating conditions which may lead to vaporization. The hydrodynamic, thermal, and nuclear phenomena of particular importance are discussed, their methods of prediction are reviewed and evaluated, and recommendations pertaining to future analyses and experiments are made. In general, experimental and analytical techniques are available to give insight to the gross behavior of vaporizing coolant. However, the technology is insufficient at present to make accurate predictions. (auth)

33127 (VDIT-61) FLOW MEASUREMENT IN REACTOR TECHNOLOGY. A GUIDE TO SPECIAL LITERATURE ON THIS MATTER. Ernst Bock (Aktiebolaget Atomenergi, Stockholm). [1962]. 5p.

A bibliography on flow-measurement problems and systems in reactor engineering is presented. Twenty-two abstracts of publications dealing with measurement of gaseous and liquid flow are given. (M.C.G.)

33128 (EURAEC-223) RESEARCH ON VIBRATIONS AND HEAD LOSSES INSIDE TUBE BUNDLES. Quarterly Report No. 5, October–December 1961. (Société Grenobloise d'Etude et d'Applications Hydrauliques, Grenoble, France). Jan. 1962. Work Performed under United States–Euratom Joint Research and Development Program. Contract [025-60-10-RDF]. 12p. A translation.

An investigation was made of the vibration of a brass rod (0.6 cm in dia. and 29.5 cm long) mounted at one end in a conduit (30 cm dia.) at a right angle to the flow and of a stainless steel tube (ID 0.9 and OD 1.2 cm and 115.0 cm long) fixed at both ends and located parallel to the flow center line of a conduit (16 cm dia.). The vibrations of the rod were monitored with reference to the rate of flow which varied from 50 to 150 cm/sec. The main vibration takes place in a plane at right angle to the flow. Its frequency and amplitude varies with the velocity. The amplitude reaches a maximum value at 112 cm/sec and subsequently drops rapidly. At the highest velocity the vibration is irregular, the amplitude falling to nearly zero at times. The vibration amplitude rises with velocity for the tube in flows of 200 to 600 cm/sec. The frequency is independent of the velocity and is equal to the self-frequency in water. The

tube vibrates in accordance with the base and higher moduli. (auth)

33129 LAMINAR NATURAL CONVECTION FLOW WITH SUCTION OR INJECTION. A. Kameswara Rao (Indian Inst. of Tech., Kharagpur). Appl. Sci. Research, 11A: 1-9(1962). (In English)

The effect of wall porosity on fully developed natural convection flow between two parallel plates maintained at constant temperatures was analyzed. It is found that the flow and heat transfer depend on three dimensionless parameters, the Prandtl number σ, the Reynolds number R, and a new dimensionless group $K = \sigma G(\beta f_x h)/(C_p)$ where G is the Grashof number, β the coefficient of volumetric expansion, C_p the specific heat at constant pressure, f_x the body force and h the distance between the plates. (auth)

33130 THE THERMAL ENTRANCE REGION IN LAMINAR POWER LAW FLOWS. William N. Gill (Syracuse Univ., N. Y.). Appl. Sci. Research, 11A: 11-12(1962). (In English)

The Mercer method is applied to power law flows in tubes. The Mercer method is an extension of the Leveque method for determining effects in the thermal entrance region of ducts without the excessive computation characteristic of eigenvalue problems. The method may be applied to flow between parallel plates. (N.W.R.)

33131 TRANSPIRATION COOLING IN A MAGNETOHYDRODYNAMIC STAGNATION-POINT FLOW. E. M. Sparrow, E. R. G. Eckert, and W. J. Minkowycz (Univ. of Minnesota, Minneapolis). Appl. Sci. Research, 11A: 125-47(1962). (In English)

An analysis was made to determine the reduction in stagnation point heat transfer by blowing and magnetic field simultaneously. It is found that in the presence of blowing, the magnetic field may be considerably more effective in reducing heat transfer than in the no-blowing case. The results show that the heat transfer reduction due to the simultaneous action of blowing and magnetic field is greater than that attained by multiplying together the separate reductions due to blowing alone and magnetic field alone. This favorable interaction diminishes as the Prandtl number diminishes and thus may be of lesser importance for highly ionized gases for which the Prandtl number is low. The analysis is carried through for both two- and three-dimensional stagnation points, and results are reported for Prandtl numbers of 0.01, 0.1, 0.7, 1, and 10. (auth)

33132 PARALLEL FLOW RECUPERATIVE MULTICHANNEL HEAT EXCHANGERS. Jerzy Wolf. Arch. Bodowy Maszyn, 9: 55-76(1962). (In Polish)

The general theory and method of solving practical problems of parallel-flow, contradirectional and unidirectional, recuperative heat exchangers with any number of channels and multiple heat exchange between them are studied. Under the assumption of a theoretical maximum number of heat couplings between the channels, a set of general differential equations describing the temperature distribution along the channels is obtained in two forms. The introduction of the notion of heat transference per unit of channel length permits the expression of these equations in a simple way and the discussion of them in an explicit manner. It is shown that all problems of this type can be reduced to a set of homogeneous linear differential equations of the first order. An example demonstrates the application of the general theory to the fundamental case of the ordinary two-channel heat exchanger. By introducing the notion of heat transference the results of the theoretical analysis of the case under consideration can be reduced to a dimensionless form. Thus the method can be used for rapid solution of numerical problems by making use of a dimensionless universal graph. (auth)

33133 TWO-PHASE FLOW AND BOILING HEAT TRANSFER TO CRYOGENIC LIQUIDS. Novak Zuber (General Electric Co., Schenectady, N. Y.) and Erwin Fried. ARS (Am. Rocket Soc.) J., 32: 1332-41(Sept. 1962).

The use of available information for predicting the rates of heat transfer to liquid hydrogen in particular and other fluids in general when a change of phase takes place is investigated and evaluated. The dimensionless groups are discussed, and various methods of correlation are compared with the experimental data for liquid hydrogen. (auth)

33134 OPTIMUM CONTOUR HEAT REJECTION FINS COOLED BY RADIATION. G. L. Grodzovskii (Grodzovsky) (Academy of Sciences, Moscow). Astronaut. Acta, 8: 232-9 (1962). (In English)

The two-dimensional problem of determination of optimum cross-section contour of a heat-rejection fin (cooled by radiation) for a prescribed minimum (non-zero) fin thickness is considered for the case of a one-sided heat supply. It is shown that the optimum fin contour consists of the two regions: that of constant (minimum) thickness close to the tip and the region of extremum contour with tip temperature prescribed. The solution attained may be considered as that for two symmetrical halves of optimum fin with two-sided heat supply for an assumed minimum fin thickness. Longitudinal cambering of heat rejection fins and cooling gas flow in a cylindrical channel (tube) is also considered. (auth)

33135 HEAT TRANSFER IN THE REGION OF THERMAL STABILIZATION FOR LIQUID METALS FLOWING TURBULENTLY THROUGH PIPES. V. I. Subbotin, M. Kh. Ibragimov, and E. V. Nomofilov. At. Energ. (USSR), 13: 155-61(Aug. 1962). (In Russian)

In previous theoretical studies of the heat transfer of turbulently flowing liquid metals at the inlet portion of the pipe (H. Poppendiek, et al. ORNL-913 & 914) the thermal contact resistance at the boundary layer between the wall and the liquid metal was not taken into account. Subsequent experimental work by others was based on the measurement of the wall temperature which is greatly affected by the contact resistance. This problem was therefore reexamined, determining the heat transfer coefficients from the temperature profile in the liquid metal stream and by direct measurements of the wall temperature. The method used allowed estimates of the inlet effects on the heat transfer together with the influence of the contact resistance to be made. Local heat transfer coefficients were determined during turbulent flow of the liquid metal at Prandtl numbers of 0.02 and Reynolds numbers between 10^4 to 10^5 while maintaining the hydrodynamic stabilization of the flow. The molecular and the turbulent heat transfer problems may be solved semi-empirically although no current theory can explain all the experimental data. The contact resistance can be treated only experimentally. (TTT)

33136 HEAT TRANSFER AND HYDRAULIC RESISTANCE IN CLOSE-PACKED ROD BUNDLES PROVIDED WITH VOIDS. P. A. Ushakov, V. I. Subbotin, B. N. Gabrianovich, V. D. Talanov, and I. P. Sviridenko. At. Energ. (USSR), 13: 162-9(Aug. 1962). (In Russian)

Grouping the fuel rods in the reactor in the form of closely-packed bundles represent a simplified design which does not require special devices to prevent deformation of the rods. The relatively high void content of 21.5% of this arrangement ensures a high flow rate of the coolant through the reactor. In order to obtain additional information about this design, heat transfer tests were carried out with Hg

and eutectic (22 to 78%) NaK alloy under an Ar blanket. A stainless steel loop and an electromagnetic pump was used, according to the method described by V. I. Subbotin et al. (Atomnaya Energiya, 9: 461 (1960) No. 6). The tests showed that the effect of the flow rate of the heat transfer agent on the temperature profile in the central pipe of the bundle is more marked in the case of Hg. The uneven temperature distribution under predetermined conditions was found to be practically independent from the thermal conductivity in the λ_3/λ_2 range from 0.54 to 1.44 where λ_2 and λ_3 designate the coefficient of thermal conductivity of the wall and of the liquid, respectively. At large Reynolds numbers the characteristic dimension of the close-packed system seems to coincide with the hydraulic diameter. The results are useful for heat transfer calculations of fuel elements. (TTT)

33137 HEAT TRANSFER FROM A STAGGERED TUBE BUNDLE IN A TRANSVERSAL STREAM OF MOLTEN SODIUM. V. M. Borishanskii, A. A. Andreevskii, and B. V. Zhinkina. At. Energ. (USSR), 13: 269-71(Sept. 1962). (In Russian)

Local and the average heat transfer data were determined by passing liquid Na through a staggered pipe bundle by means of a closed, forced-circulation loop. The O content of the Na was reduced to 2.6×10^{-3}% by placing a cold trap in the system, and carrying out the tests under a protective Ar atmosphere. The amount of heat transferred was measured by means of an electrocalorimeter in the hydraulically stabilized portion of the system at Na temperatures between 200 and 350°C, at flow rates ranging from 0.1 to 2.0 m/sec and Reynolds Nos. between 4700 and 90,000. It was found that in the rear portion of the pipe the heat transfer coefficient decreases smoothly. The peripheral heat transfer distribution showed a maximum, but the second maximum, usually observed when nonmetallic liquids are used, was not noted. Comparison with previously reported heat transfer data of Hg (C. Pickard et al., Trans. ASME 80: 646(1958) No. 3) showed good agreement between the two liquid metals; a similar agreement was found also with the theory developed by R. Cess and R. Crosh (Trans. ASME 80: 677(1958) No. 3). (TTT)

33138 INCIPIENT BOILING AND THE BUBBLE BOUNDARY LAYER FORMATION OVER A HEATED PLATE FOR FORCED CONVECTION FLOW IN A PRESSURIZED RECTANGULAR CHANNEL. Latif Menashi Jiji (Univ. of Michigan, Ann Arbor). Dissertation Abstr., 23: 585(Aug. 1962).

The inception of bubbles for forced convection flow over a heated plate in a pressurized channel and their consequent mutual interaction in the formation of a bubble boundary layer was investigated. A high pressure closed loop was designed to permit visual obeervation of boiling over a heated plate and to provide temperature measurements of the boiling fluid. The plate, which is 0.50 in. wide and 9.48 in. long, was vertically oriented in a 0.50×0.46 in. rectangular channel. Photographs and temperature profile measurements were obtained for forced convection boiling of distilled water at pressures of 200 to 1000 psia, velocities of 1 to 6 ft/sec, subcoolings of 50 to 300°F and heat flux of 0.14×10^6 to 1.5×10^6 Btu/hr-ft^2. A correlation equation for the incipient heat flux (the flux necessary to initiate observable bubbles) was obtained. The equation predicts incipient heat flux to within ±15%. The bubble boundary layer thickness was correlated to within ±20% by a dimensionless equation. Temperature profiles at various locations from the leading edge were measured. The mean temperature at the single-phase core-bubble boundary layer interface was found to approach inlet temperature as heat flux is increased toward its maximum value. Large temperature fluctuations were detected in both the single-phase core and the bubble boundary layer. The temperature fluctuations indicate the existence of subcooled liquid at the inlet temperature along the single-phase core-bubble boundary layer interface. It was also observed that the amplitude of temperature fluctuations near the heated surface decreases as the heat flux is increased. This suggests that burnout is characterized by the formation of a stagnant layer of superheated vapor near the surface.

33139 DEVICE FOR TRANSMITTING A REVOLUTION MOVEMENT TO THE COOLANT OF A NUCLEAR REACTOR ENCLOSED BY A DOUBLE-WALLED CONTAINER. (to Brown, Boveri and Cie. A.G.). French Patent 1,246,587. Oct. 10, 1960.

The coolant of a reactor which is enclosed by a double-walled container is circulated by a blower situated inside the inner wall. The blower motor is positioned outside the container. Generally the two walls are submitted to different thermal expansions, so that special measures are necessary for ensuring the tight transmission of the revolution movement from the motor to the blower. Preferably the space bounded by the two walls is filled with a barrier gas at a pressure higher than the pressure of the reactor coolant. The inner wall is extended at its bottom by a tubular collar having lateral protuberances in which the blowers are situated and which supports the bearings of the blower rotor axle. The outer wall also shows at its bottom lateral protuberances nearly in alignment with corresponding protuberances of the inner wall and provided with bearings for an axle section coupled with the motor. This latter axle section is coupled with the blower rotor axle by a double cardan shaft and a grooved shaft axially slidable in a corresponding axial hole provided in the blower rotor axle so that the mutal movements of the protuberances do not disturb the transmission of the revolution movement. (NPO)

33140 THERMAL PRESSURIZER. (to Commissariat à l'Énergie Atomique). French Patent 1,263,383. May 2, 1961.

Thermal pressurizers serve to maintain in a hydraulic circuit, e.g., in a reactor, a predetermined pressure reacting very quickly upon changes in pressure essentially caused by changes in volume. Generally a thermal pressurizer comprises a pressure vessel in a lower part of which the liquid is held at the saturation temperature corresponding to the working pressure, while the space over the free liquid level in the vessel is occupied by saturated vapor. Means are provided to ensure an intensified condensation of the vapor in case the liquid volume increases quickly, e.g., by an increase of temperature. This means ensures that the greater part of the liquid flowing into the pressurizer is led into the vessel at a point near the free liquid level. This injected liquid has a temperature lower than the saturation temperature and activates the condensation of the vapor. (NPO)

33141 SUBDIVISION OF ECONOMIZERS OF A THERMAL INSTALLATION. (to Compagnie des Surchauffeurs). French Patent 1,264,648. May 15, 1961.

In a thermal installation where a hot fluid coming from a reactor passes successively through superheaters, an evaporator, and an economizer, it is necessary to prevent low-temperature fluid leaving the economizer and being recycled into the reactor. Thus, this economizer consists of grouped coaxial spiral tubes, the tube of the same group having the same entrance header. The feeding of each group is controlled independently. (NPO)

33142 BOILER FOR THE RECOVERY OF HEAT OF A PRESSURIZED FLUID. (to Société Francaise des Constructions Babcock and Wilcox). French Patent 1,270,133. July 17, 1961.

A boiler for the recovery of heat from a pressurized fluid comprises a pressure vessel composed of a spherical evaporating chamber and two cylindrical parts disposed coaxially at the top and bottom of this evaporating chamber. These two chambers communicate mutually via a cylindrical connection passing through the center of the evaporating chamber, the tubes of the economizer and evaporator being placed in the lower cylindrical chamber, while the tubes of the superheater are disposed in the upper one. The cylindrical connection is double walled. Steam-water separators are disposed within the evaporating chamber. The transition from the open extremities of the cylindrical to the inner surfaces connection of the cylindrical chambers is performed by baffle sheets having the shape of truncated cones. For assembling the cylindrical chamber with the spherical evaporating chamber, the open edges of the cylindrical walls provided with castle-nuts are welded onto the outer surface of the evaporating chamber. The tightness of this connection is ensured by thin toroidal sheets welded to both the evaporating chamber wall and to the inner surfaces of the cylinders. Preferably the interspace between these toroidal sheets and the baffle sheets is filled with thermal insulating material. (NPO)

33143 HEAT EXCHANGER. T. H. Fox, III, Thomas Richey, Jr., and G. R. Winders (to U. S. Atomic Energy Commission). U. S. Patent 3,059,908. Oct. 23, 1962.

A heat exchanger is designed for use in the transfer of heat between a radioactive fluid and a non-radioactive fluid. The exchanger employs a removable section containing the non-hazardous fluid extending into the section designed to contain the radioactive fluid. The removable section is provided with a construction to cancel out thermal stresses. The stationary section is pressurized to prevent leakage of the radioactive fluid and to maintain a safe, desirable level for this fluid. (AEC)

Instrumentation

Refer also to abstracts 33476 and 33330.

33144 (62-RL-3047E) SWITCHING A 384-KILOJOULE, LOW-INDUCTANCE CAPACITOR BANK. L. M. Goldman, H. C. Pollock, and J. A. Reynolds (General Electric Co. Research Lab., Schenectady, N. Y.). June 1962. 13p.

Modifications on the spark gaps and trigger circuit of a 384-kilojoule capacitor bank are described which reduce the jitter time from about 1 μsec to less than 25 mμsec. The design retains the use of three electrode spark gaps that can handle high energy (96 kj) and charge (3 coulombs). The operating range is from 30 to 60 kv, and the total bank inductance is 20 mμh. During initial tests 1000 firings produced no significant wear or variation of the electrical characteristics. (auth)

33145 (AERE-R-3953) THE APPLICATION OF THE LIGHT ABSORPTION TECHNIQUE TO CONTINUOUS FILM THICKNESS RECORDING IN ANNULAR TWO-PHASE FLOW. G. F. Hewitt and P. C. Lovegrove (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). July 1962. 14p.

An attempt was made to measure continuously the instantaneous thickness of the climbing film in vertical co-current air/water flow by means of the absorption of a light beam in a dye added to the water. A single passage of the light through the film was arranged by bringing it up close to the inner surface of the film through an air-purged capillary tube which penetrated one wall and traversed most of the droplet-laden air core; after passage through the film and the transparent wall the light fell on a photovoltaic cell whose signal was amplified and displayed on an oscilloscope. Although this general method was reported as satisfactory with falling films, the sharp wave profiles and presence of spray in the climbing film regime of interest were found to introduce gross refraction and scattering effects which swamped other signals. The technique was abandoned. (auth)

33146 (ASD-TDR-62-348) A HIGH TEMPERATURE THERMAL CONDUCTIVITY APPARATUS. R. E. Taylor (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 1962. Contract AF 33(657)-7136. 27p.

A high-temperature, steady-state thermal conductivity apparatus is described. This apparatus was used to measure the conductivity of diverse materials, such as graphite, metals, carbides, oxides, and liquid Cu. Measurements were made at 200 to 2500°C. The procedures used, difficulties encountered, limitations, and accuracy are discussed. Results previously obtained with this apparatus on graphite, Mo, Ta, porous C, liquid Cu, Armco Fe, beryllia, magnesia, and titanium carbide are presented graphically and are compared with other results. (auth)

33147 (CEA-2183) ETUDE EXPERIMENTALE DE L'EVOLUTION DANS LE TEMPS DU PROFIL DES RAIES SPECTRALES. (Experimental Study of the Variation of Spectrum Line Profiles with Time). Guy Laval and René Pellat (European Atomic Energy Community and France. Commissariat a l'Energie Atomique, Paris). 1962. 37p.

A study was made relating to a device conceived by C. Breton, M. Capet, and F. Waelbroeck and submitted at the Fifth International Conference on Ionization Phenomena in Gases (Munich 1961). To calibrate the device and to know its accurate possibilities, noise in photomultipliers had to be investigated. For weak light signals, this investigation showed that the Schottky effect explains this noise and that there is a strict relation between the time resolution and the accuracy of the results. These results were applied to measurements of Stark Effect broadening of the Dβ line emitted by the plasma of an electrodeless-gun. The densities calculated from the experimental profiles are in good agreement with the densities calculated from magnetic measurements. (auth)

33148 (HW-SA-2685) IMPROVED MACRO CAMERA FOR HOT CELL APPLICATION. C. L. Boyd (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [July 24, 1962]. Contract AT(45-1)-1350. 10p.

Improved photographic equipment for hot cell application is described. The camera incorporates a high density Pb-glass shielding window as a part of the bellows extension. This feature reduces the light reflection in the window without reducing the transmitted image size. Photomacrographs and low power photomicrographs of good definition and depth of field were routinely taken using this equipment. The resolution of these photographs is about 2000 lines/in. (J.R.D.)

33149 (INSJ-49) A DESIGN CONSIDERATION OF THE ALTERNATING COUNTING SYSTEM FOR LOW-LEVEL RADIATION MEASUREMENTS. Shinkichi Shibata and Kazuo Yamakoshi (Tokyo Univ. Inst. for Nuclear Study). July 12, 1962. 22p.

and eutectic (22 to 78%) NaK alloy under an Ar blanket. A stainless steel loop and an electromagnetic pump was used, according to the method described by V. I. Subbotin et al. (Atomnaya Energiya, 9: 461 (1960) No. 6). The tests showed that the effect of the flow rate of the heat transfer agent on the temperature profile in the central pipe of the bundle is more marked in the case of Hg. The uneven temperature distribution under predetermined conditions was found to be practically independent from the thermal conductivity in the λ_3/λ_2 range from 0.54 to 1.44 where λ_2 and λ_3 designate the coefficient of thermal conductivity of the wall and of the liquid, respectively. At large Reynolds numbers the characteristic dimension of the close-packed system seems to coincide with the hydraulic diameter. The results are useful for heat transfer calculations of fuel elements. (TTT)

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33139 DEVICE FOR TRANSMITTING A REVOLUTION MOVEMENT TO THE COOLANT OF A NUCLEAR REACTOR ENCLOSED BY A DOUBLE-WALLED CONTAINER. (to Brown, Boveri and Cie. A.G.). French Patent 1,246,587, Oct. 10, 1960.

The coolant of a reactor which is enclosed by a double-walled container is circulated by a blower situated inside the inner wall. The blower motor is positioned outside the container. Generally the two walls are submitted to different thermal expansions, so that special measures are necessary for ensuring the tight transmission of the revolution movement from the motor to the blower. Preferably the space bounded by the two walls is filled with a barrier gas at a pressure higher than the pressure of the reactor coolant. The inner wall is extended at its bottom by a tubular collar having lateral protuberances in which the blowers are situated and which supports the bearings of the blower rotor axle. The outer wall also shows at its bottom lateral protuberances nearly in alignment with corresponding protuberances of the inner wall and provided with bearings for an axle section coupled with the motor. This latter axle section is coupled with the blower rotor axle by a double cardan shaft and a grooved shaft axially slidable in a corresponding axial hole provided in the blower rotor axle so that the mutal movements of the protuberances do not disturb the transmission of the revolution movement. (NPO)

33140 THERMAL PRESSURIZER. (to Commissariat à l'Énergie Atomique). French Patent 1,263,383. May 2, 1961.

Thermal pressurizers serve to maintain in a hydraulic circuit, e.g., in a reactor, a predetermined pressure reacting very quickly upon changes in pressure essentially caused by changes in volume. Generally a thermal pressurizer comprises a pressure vessel in a lower part of which the liquid is held at the saturation temperature corresponding to the working pressure, while the space over the free liquid level in the vessel is occupied by saturated vapor. Means are provided to ensure an intensified condensation of the vapor in case the liquid volume increases quickly, e.g., by an increase of temperature. This means ensures that the greater part of the liquid flowing into the pressurizer is led into the vessel at a point near the free liquid level. This injected liquid has a temperature lower than the saturation temperature and activates the condensation of the vapor. (NPO)

33141 SUBDIVISION OF ECONOMIZERS OF A THERMAL INSTALLATION. (to Compagnie des Surchauffeurs). French Patent 1,264,648. May 15, 1961.

In a thermal installation where a hot fluid coming from a reactor passes successively through superheaters, an evaporator, and an economizer, it is necessary to prevent low-temperature fluid leaving the economizer and being recycled into the reactor. Thus, this economizer consists of grouped coaxial spiral tubes, the tube of the same group having the same entrance header. The feeding of each group is controlled independently. (NPO)

33142 BOILER FOR THE RECOVERY OF HEAT OF A PRESSURIZED FLUID. (to Société Francaise des Constructions Babcock and Wilcox). French Patent 1,270,133. July 17, 1961.

A boiler for the recovery of heat from a pressurized fluid comprises a pressure vessel composed of a spherical evaporating chamber and two cylindrical parts disposed coaxially at the top and bottom of this evaporating chamber. These two chambers communicate mutually via a cylindrical connection passing through the center of the evaporating chamber, the tubes of the economizer and evaporator being placed in the lower cylindrical chamber, while the tubes of the superheater are disposed in the upper one. The cylindrical connection is double walled. Steam-water separators are disposed within the evaporating chamber. The transition from the open extremities of the cylindrical to the inner surfaces connection of the cylindrical chambers is performed by baffle sheets having the shape of truncated cones. For assembling the cylindrical chamber with the spherical evaporating chamber, the open edges of the cylindrical walls provided with castle-nuts are welded onto the outer surface of the evaporating chamber. The tightness of this connection is ensured by thin toroidal sheets welded to both the evaporating chamber wall and to the inner surfaces of the cylinders. Preferably the interspace between these toroidal sheets and the baffle sheets is filled with thermal insulating material. (NPO)

33143 HEAT EXCHANGER. T. H. Fox, III, Thomas Richey, Jr., and G. R. Winders (to U. S. Atomic Energy Commission). U. S. Patent 3,059,908. Oct. 23, 1962.

A heat exchanger is designed for use in the transfer of heat between a radioactive fluid and a non-radioactive fluid. The exchanger employs a removable section containing the non-hazardous fluid extending into the section designed to contain the radioactive fluid. The removable section is provided with a construction to cancel out thermal stresses. The stationary section is pressurized to prevent leakage of the radioactive fluid and to maintain a safe, desirable level for this fluid. (AEC)

Instrumentation

Refer also to abstracts 33476 and 33330.

33144 (62-RL-3047E) SWITCHING A 384-KILOJOULE, LOW-INDUCTANCE CAPACITOR BANK. L. M. Goldman, H. C. Pollock, and J. A. Reynolds (General Electric Co. Research Lab., Schenectady, N. Y.). June 1962. 13p.

Modifications on the spark gaps and trigger circuit of a 384-kilojoule capacitor bank are described which reduce the jitter time from about 1 μsec to less than 25 mμsec. The design retains the use of three electrode spark gaps that can handle high energy (96 kj) and charge (3 coulombs). The operating range is from 30 to 60 kv, and the total bank inductance is 20 mμh. During initial tests 1000 firings produced no significant wear or variation of the electrical characteristics. (auth)

33145 (AERE-R-3953) THE APPLICATION OF THE LIGHT ABSORPTION TECHNIQUE TO CONTINUOUS FILM THICKNESS RECORDING IN ANNULAR TWO-PHASE FLOW. G. F. Hewitt and P. C. Lovegrove (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). July 1962. 14p.

An attempt was made to measure continuously the instantaneous thickness of the climbing film in vertical co-current air/water flow by means of the absorption of a light beam in a dye added to the water. A single passage of the light through the film was arranged by bringing it up close to the inner surface of the film through an air-purged capillary tube which penetrated one wall and traversed most of the droplet-laden air core; after passage through the film and the transparent wall the light fell on a photovoltaic cell whose signal was amplified and displayed on an oscilloscope. Although this general method was reported as satisfactory with falling films, the sharp wave profiles and presence of spray in the climbing film regime of interest were found to introduce gross refraction and scattering effects which swamped other signals. The technique was abandoned. (auth)

33146 (ASD-TDR-62-348) A HIGH TEMPERATURE THERMAL CONDUCTIVITY APPARATUS. R. E. Taylor (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 1962. Contract AF 33(657)-7136. 27p.

A high-temperature, steady-state thermal conductivity apparatus is described. This apparatus was used to measure the conductivity of diverse materials, such as graphite, metals, carbides, oxides, and liquid Cu. Measurements were made at 200 to 2500°C. The procedures used, difficulties encountered, limitations, and accuracy are discussed. Results previously obtained with this apparatus on graphite, Mo, Ta, porous C, liquid Cu, Armco Fe, beryllia, magnesia, and titanium carbide are presented graphically and are compared with other results. (auth)

33147 (CEA-2183) ETUDE EXPERIMENTALE DE L'EVOLUTION DANS LE TEMPS DU PROFIL DES RAIES SPECTRALES. (Experimental Study of the Variation of Spectrum Line Profiles with Time). Guy Laval and René Pellat (European Atomic Energy Community and France. Commissariat a l'Energie Atomique, Paris). 1962. 37p.

A study was made relating to a device conceived by C. Breton, M. Capet, and F. Waelbroeck and submitted at the Fifth International Conference on Ionization Phenomena in Gases (Munich 1961). To calibrate the device and to know its accurate possibilities, noise in photomultipliers had to be investigated. For weak light signals, this investigation showed that the Schottky effect explains this noise and that there is a strict relation between the time resolution and the accuracy of the results. These results were applied to measurements of Stark Effect broadening of the Dβ line emitted by the plasma of an electrodeless-gun. The densities calculated from the experimental profiles are in good agreement with the densities calculated from magnetic measurements. (auth)

33148 (HW-SA-2685) IMPROVED MACRO CAMERA FOR HOT CELL APPLICATION. C. L. Boyd (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [July 24, 1962]. Contract AT(45-1)-1350. 10p.

Improved photographic equipment for hot cell application is described. The camera incorporates a high density Pb-glass shielding window as a part of the bellows extension. This feature reduces the light reflection in the window without reducing the transmitted image size. Photomacrographs and low power photomicrographs of good definition and depth of field were routinely taken using this equipment. The resolution of these photographs is about 2000 lines/in. (J.R.D.)

33149 (INSJ-49) A DESIGN CONSIDERATION OF THE ALTERNATING COUNTING SYSTEM FOR LOW-LEVEL RADIATION MEASUREMENTS. Shinkichi Shibata and Kazuo Yamakoshi (Tokyo Univ. Inst. for Nuclear Study). July 12, 1962. 22p.

An alternating counting system was developed to reduce the effects of fluctuations in low-level radiation measurements. A standard sample and test sample are alternatively measured for a determined interval and integrated counts for each sample are compared. Calculations and curves are presented. (M.C.G.)

33150 (ISS-61/30) SERIE DI APPARECCHI TRANSISTORIZZATI PER L'ELABORAZIONE DEGLI IMPULSI DI CONTATORI A SCINTILLAZIONE. (Series of Transistorized Apparatus for the Elaboration of Impulses of Scintillation Counters). M. Ageno and C. Felici (Italy. Istituto Superiore di Sanità, Rome). June 18, 1961. 27p.

A summary description is given of a complex of electronic devices constructed during the last year at the Istituto Superiore de Sanita, Roma. The required characteristics of the apparatus are first reviewed. Then scintillation counters, delay circuits, fast amplifiers, threshold and channel amplitude analyzers, and coincidence and anticoincidence circuits are considered. (J.S.R.)

33151 (NAA-SR-Memo-7598) APPARENT STRAIN vs TEMPERATURE vs CYCLES FOR SODIUM STRAIN GAGES. M. M. Lemcoe (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). July 25, 1962. Contract [AT-11-1-GEN-8]. 5p.

In order to stabilize and calibrate three sodium strain gages to be used for measuring stresses in the 30 Mw IHX, they were precycled in the transient heating facility. The apparent strain vs temperature vs cycles curves for these gages as obtained with an x-y plotter are presented. (auth)

33152 (NP-12094) SURFACE BURST OF A 100 TON TNT HEMISPHERICAL CHARGE (1961) FIELD INSTALLATION OF INSTRUMENTATION FOR THE PHYSICS AND METEOROLOGY SECTION. Suffield Technical Note No. 87. F. H. Winfield (Canada. Suffield Experimental Station, Ralston, Alberta). July 13, 1962. 23p.

The measurements made on the 100 ton blast trial held at Suffield Experimental Station are presented with descriptions of the associated apparatus or instrumentation. A general description is also given of the complete layout and instrumentation. (auth)

33153 (PAN-324/I-A) FAST NEUTRON TIME-OF-FLIGHT SPECTROMETER. Zbigniew Moroz (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). May 1962. 14p.

An apparatus for time measurements in the millimicrosecond region, suitable for use in time-of-flight fast neutron spectrometry and short lifetime measurements were constructed. Results of testing experiments with γ sources of Co^{60}, Hg^{197m_1} and Er^{169} and neutron t.o.f. spectrum for the E_n = 14 Mev are presented. (auth)

33154 (TID-16678) THE USE OF AN INTERNAL LIQUID HYDROGEN TARGET WITH A METHYL IODIDE BUBBLE CHAMBER. M. Chretien (Brandeis Univ., Waltham, Mass.); D. R. Firth (Harvard Univ., Cambridge, Mass.); R. K. Yamamoto, I. A. Pless, and L. Rosenson (Massachusetts Inst. of Tech., Cambridge, Mass. Lab. for Nuclear Science). (June 15, 1962). Contract [AT (30-1)-2098]. 5p.

Design and use of a 15 in. dia. by 14 in. deep methyl iodide chamber with a small internal target of liquid H_2 are described. Such a system is useful for the study of reactions on free protons with π^0 among the products. (J.R.D.)

33155 (TID-16753) DEVELOPMENT LEADING TO AN IMPROVED DENSITOMETER FOR HELIUM–GRAPHITE OR NITROGEN–GRAPHITE FLOW STREAMS. Quarterly Report No. 189-9, May–July 1962. Donald H. Strobel (Badger Meter Mfg. Co., Milwaukee). Aug. 31, 1962. Contract AT(11-1)-1111. 17p.

Activities in a development program of an instrument for measuring the density of He–graphite and/or N_2–graphite mixtures are reported. Preliminary testing was initiated on the various instrument components. It is expected that all testing will be completed during the next report period. (J.R.D.)

33156 (TID-16829) MECHANICAL DECLADDING OF EBR II FUEL ELEMENTS. J. P. Simon and J. R. White (Argonne National Lab., Ill.). July 1962. Contract [W-31-109-eng-38]. 20p. (UAC-6673)

A semi-automatic, remotely operated machine was fabricated for the purpose of mechanically decladding the Experimental Breeder Reactor II fuel elements. Three knurled drive rollers and a single point tool provide a fast, chipless method of separating the spent fuel and its cladding. The machine was designed to facilitate remote repair work. The use of conventional organic materials for pneumatic seals, lubrication, and electrical insulation was excluded due to the deteriorating effects of radiation. An earlier version of the machine decanned 4500 unirradiated uranium fuel elements in a dry inert atmosphere. (auth)

33157 (UCRL-7071) LOW-POWER PULSING OF STRAIN GAGES ON PLASTIC MATERIALS. C. Eugene Makerov (California. Univ., Livermore. Lawrence Radiation Lab.). Sept. 25, 1962. Contract W-7405-eng-48. 28p.

An experimental study was made to obtain accurate strains from strain gages on plastic materials. By using short-duration, high-voltage pulses (25 and 50 μsec at 55 volts) at low repetitive rates (2 cps), the power input into the strain gage was kept low (below $2\frac{1}{2}$ milliwatts), thereby minimizing the local temperature rise ($\Delta T = 1°F$) and minimizing the loss in the material's modulus ($\Delta E = -800$ psi/°F). It was determined also that sensitivity of strain gages increases linearly to 61 $\mu v/\mu\epsilon$ with 55-volt pulses, which is a five- to tenfold increase over the d-c type of strain-gage instrumentation. A full range of tensile-to-compressive strains (± 1000 μin./in.) was induced in a plastic beam in a constant-moment fixture, and comparisons were made between d-c and pulsed type of data acquisition. From these parameters, a ten-channel unit is now being designed for stress analysis tests, both static and dynamic. (auth)

33158 (UCRL-10250) A MAGNETIC SPECTROMETER USING SPARK CHAMBERS TO OBTAIN LARGE SOLID ANGLE AND HIGH RESOLUTION IN π-π INTERACTION STUDIES. D. Keefe, L. T. Kerth, C. M. Noble, J. J. Thresher, and W. A. Wenzel (California. Univ., Berkeley. Lawrence Radiation Lab.). May 28, 1962. Contract W-7405-eng-48. 6p.

The design of a large-aperture magnetic spectrometer employing spark chambers coupled with a large bending magnet is described. Its advantages in meson (π)-nucleon interaction studies are listed. A schematic view is given of a system constructed to analyze final-state particles from π^+-p interactions at 2 to 5 Bev/c. Operation of the spectrometer is discussed. (M.C.G.)

33159 (UCRL-10266) A MULTICHANNEL COINCIDENCE SYSTEM. Robert W. Kenney (California. Univ., Berkeley. Lawrence Radiation Lab.). May 28, 1962. Contract W-7405-eng-48. 9p.

The electronic system associated with a Bevatron pion-nuclear scattering experiment is described in which 50 counters were combined in various ways into 64 coinci-

dence channels. The system is simplified in the description for the sake of brevity and is intended to present only the basic ideas involved. (J.R.D.)

33160 (UCRL-10278) AN ELECTRONIC ANALOG SYSTEM FOR KINEMATICAL ANALYSIS OF INTERACTION VERTICES. Joseph J. Murray (California. Univ., Berkeley. Lawrence Radiation Lab.). June 6, 1962. Contract W-7405-eng-48. 6p.

An electric analog system was developed for analysis of bubble chamber events that do not fit any of the common hypotheses. Inputs to PLEB are obtained from the geometrical reconstruction program. The system is a fully automatic steady-state analog requiring a few seconds to reach equilibrium. The basis for the analog is discussed, and major sections are described. (M.C.G.)

33161 (USNRDL-TR-574) A LOW RATE PORTABLE COUNTER. R. H. Sorenson and G. T. Kiyoi (Naval Radiological Defense Lab., San Francisco). June 28, 1962. 18p.

Measurement of low radiation levels is difficult with present count-rate radiacs because of the excessive meter fluctuations on the low ranges. An accessory was developed which increases the readability of the low ranges in these devices. The Low Rate Portable Counter is intended for use where the counting rates are below 5000 counts per minute. The instrument utilizes the output pulse normally used to operate headphones, and supplies the operator with a digital display in counts for a preset time. Four fixed counting periods are available: 2, 4, 8, and 15 min. Transistor circuitry is employed and power is supplied by an internal rechargeable battery source or from a 115-v, 60-cycle line. The a-c power supply is also used to recharge the battery pack. The instrument described is intended to be a preliminary model; and although electrical performance was found to be satisfactory, military requirements for vibration and shock were not adhered to. (auth)

33162 (WCAP-2053) MINIATURE NEUTRON DETECTOR DEVELOPMENT. Quarterly Progress Report for Period April 1–June 30, 1962. J. Weisman, ed. (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). Work performed under United States–Euratom Joint Research and Development Program. Contract AT(30-1)-8827. 18p. (EURAEC-419)

Significant progress in the production of SiC diodes is reported. Four additional diodes capable of counting α particles were produced. A satisfactory procedure for attaching electrical connection was developed and the new diodes were provided with leads. A preliminary electron damage test of single diode was conducted in air at ambient temperatures. Following irradiation with 1.2×10^{16} electrons/cm^2, the α-particle counting characteristics, over the temperature range of zero to 400°C, were seriously degraded but still usable. Upon further heating the detector characteristics were suddenly and permanently damaged. The cause of this latter failure is not known. (auth)

33163 (AEC-tr-5390) A SNECMA SUCCESS: THE AXIAL BLOWER WITH ROTOR BLADES ADJUSTABLE DURING OPERATION. Translated for Oak Ridge National Lab., Tenn., from Inform. SNECMA, No. 98, 73-83([1962]). 19p.

A blower was constructed and tested for endurance under conditions close to those of its application in a nuclear plant. This test consisted of 3000 consecutive hours of operation accompanied by more than 100,000 changes in the pitch of the rotor blades. In this design the adjustment of the rotor blades can be varied in a continuous manner during operation of the machine. The blower can be operated by steam, fuel gas, or electricity. It was concluded that the machine can be operated continuously for a period of 10,000 hr. The machine was designed to adapt to a variable-speed power supply with a resulting improvement in the economy of utilization. (M.C.G.)

33164 (AEC-tr-5401) PLASTIC SCINTILLATORS FOR RECORDING THERMAL NEUTRONS. E. E. Baroni, D. V. Viktorov, I. M. Rozman, and V. M. Shoniya. Translated from p.131-8 of "Proceedings of Conference on Nuclear Electronics held in Belgrade, May 15-20, 1961. Vol. I" (a publication of the International Atomic Energy Agency, 1962.) (STI/PUB-42(Vol.I(p.131-8)). 13p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, abstract no. 20717.

33165 (AEC-tr-5402) A SYSTEM OF INDICATING THE COORDINATES OF PARTICLE ENTRY INTO AN EMULSION CHAMBER (SCINTILLATION COUNTER |STsU-1). A. S. Dvoretskii, R. A. Serebryakov, I. V. Kolesov, B. F. Sikodenko, Yu. Oravets, N. S. Frolov, V. A. Kazakov, and I. I. Skryl. Translated from p.313-20 of "Proceedings of the Conference on Nuclear Electronics, held in Belgrade, May 15-20, 1961. Vol. I" (a publication of the International Atomic Energy Agency, Vienna, 1962). (STI/PUB/42(Vol.I(p.313-20)). 11p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, abstract no. 20737.

33166 (AEC-tr-5403) A PULSE SCALER USING A NEW MULTI-STABLE SYSTEM. E. Dzhakov, A. Markov, K. Sakalyan, and B. Shebeshten. Translated from p.369-77 of "Proceedings of the Conference on Nuclear Electronics, held in Belgrade, May 15-20, 1961. Vol. II" (a publication of the International Atomic Energy Agency, Vienna, 1962). (STI/PUB/42(Vol.II(p.369-77)). 10p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, abstract no. 20794.

33167 (AEC-tr-5407) MULTI-CHANNEL TIME-ANALYZER WITH ELECTROSTATIC MEMORY TUBE. K. G. Ignat'ev, I. V. Kirpichnikov, and S. I. Sukhoruchkin. Translated from p.215-9 of "Proceedings of the Conference on Nuclear Electronics, held in Belgrade, May 15-20, 1961. Vol. II" (a publication of the International Atomic Energy Agency, Vienna, 1962.) (STI/PUB/42 (Vol.II(p.215-19)). 8p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, abstract no. 20780.

33168 (AEC-tr-5411) DEVICES FOR PROCESSING OF DATA FROM MULTI-CHANNEL ANALYZERS. L. A. Matalina, S. I. Chubarova, and A. S. Tishechkina. Translated from p.121-5 of "Proceedings of the Conference on Nuclear Electronics, held in Belgrade, May 15-20, 1961. Vol. II" (a publication of the International Atomic Energy Agency, Vienna, 1962). (STI/PUB/42(Vol.II(p.121-5)). 7p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, abstract no. 20771.

33169 (AEC-tr-5415) CERIUM-ACTIVATED VITREOUS SCINTILLATORS FOR NEUTRON DETECTION. V. K. Voitovetskii and N. S. Tolmacheva. Translated from p.127-30 of "Proceedings of the Conference on Nuclear Electronics, held in Belgrade, May 15-20, 1961. Vol. I" (a publication of the International Atomic Energy Agency, Vienna, 1962). (STI/PUB/42(Vol.I(p.127-30)). 7p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, abstract no. 20716.

33170 (NP-tr-920) DETECTION OF LOW-ENERGY β^- RAYS. PART 2. C. Brooke and R. Schayes. Translated by R. R. Inston (U.K.A.E.A. Atomic Energy Re-

search Establishment, Harwell, Berks, Eng.) from Rev. M.B.L.E., 4: 222-49(1961). 60p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, as abstract no. 14965.

33171 CONSTRUCTION AND CHARACTERISTICS OF A NEUTRON CRYSTAL SPECTROMETER. J. Montes Ponce de León and L. Mañas Díaz (Grupo Operación Reactor JEN-1, Madrid). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 58: 119-24(Mar.-Apr. 1962). (In Spanish)

The characteristics and accuracy that can be achieved with a crystal spectrometer built for the JEN-1 reactor are described. A NaCl crystal was used to make the first measurements. (auth)

33172 MULTICHANNEL GAMMA-SPECTROMETER WITH A TIME ANALYZER. A. A. Bragin, I. N. Lisitskaya, V. N. Mikhaylovskii, and A. N. Svenson. Avtomat. Kontrol' i Izmeritel'. Tehk., No. 4, 124-32(1960).

A measuring apparatus in the form of a multi-channel amplitude analyzer with a time selector is described. It measures the intensity, energy, and time of radiation, and is utilized in radioactive sampling. The underground instrument consists of an impulse neutron tube; a radioactive radiation indicator; an electronic control switch operated by synchro-impulses from the neutron tube; and a frequency modulator. A frequency discriminator, a multichannel amplitude analyzer, and a conversion block are placed on the surface. The communication between the bottom and the surface instruments is achieved by means of a single channel telecommunication system. A block diagram of the instrument is given. The main circuits of most characteristic units and blocks are analyzed. An electronic switch consisting of three cathode repeaters passes through an impulse which appears during a given time interval and stops all remaining impulses, including those that appear during the given interval, but arrive after the first impulse. Protection against the effect of splitting an impulse is provided. Instability of the transfer characteristic of the switch is 1–1.5%, nonlinearity 3–5%. A multichannel amplitude analyzer consisting of shaping blocks, a pre-discrimination, and an impulse sorter with several channel outputs, which have a recording counting system connected to them is included. The operation of the impulse sorter is described in detail. The circuit of the counting block of the recording system is provided. The counter consists of a solid state binary counting circuit with a mechanical counter at the output. The position of the trigger units is fixed by means of indicating lamps connected via polarized relays. (Referativnyy Zhurnal, Automatika i radioelektronika, No. 9, 1961).

33173 THE PCY-1 (RSU-1) RADIOISOTOPE TRACKING LEVEL GAGE. V. S. Gostishchev and A. D. Kulikov. Byull. Tekh.-Ekon. Inform., Ministerstvo Morsk. Flota, No. 2, 26-9(1962).

A new RSU-1 radioisotope tracking level gage with float is reported. The level gage is intended for the automatic measurement and regulation of the liquid level in closed and open vessels, and also for the dosing of such liquids. The device can be used in all fields of industry for the automation of processes connected with the storage and processing of liquids. The RSU-1 level gage consists of the electronic relay block, which is a two-channel gamma-relay, and a column with the tracking unit. An electromagnetic reversing trigger, which is controlled by signals of the electronic relay block and serves to reverse the motor of the tracking system is used. The latter consists of the electromotor, a two-stage worm reducer, screw, clasp, nut with lead wedge and column base. The float with the gamma-radiation source (isotope of cobalt Co^{60} or cesium Cs^{137}) of an activity of 0.1–0.2 mg-equiv. radium is made of stainless steel, fluoroplastic, and glass. In the neutral position the gamma source radiates simultaneously on a group of counters located both above and below the lead wedge, as a result of which a pulse current passes through the load resistor of the upper and lower counter groups whose constant component is proportional to the counting rate. If the level changes and, consequently the float position, the counter group is radiated nonuniformly which causes them to shift until the given liquid level is attained. A detailed description of the functioning of the device and the following technical data are given: Level measurement range–0–1,000 mm; level measuring accuracy–± 10 mm; tracking speed–500 mm/min; minimum radiation intensity of counters–100 impulses/sec; rated supply voltage of the electronic relay block at 50 cps frequency–220 v; maximum current passing through the regulation unit contacts–3 amp; overall dimensions: of the electronic relay block–110 × 180 × 250 mm, of the column–1,360 × 385 × 230 mm; weight: of the block–4.7 kg, of the column–35.0 kg. The device was successfully tested on distillation columns. (OTS)

33174 A NUCLEAR BURST ALARM TESTER. D. J. Baker, F. R. Brown, and C. L. Wyatt (Utah State Univ., Logan). Electron. Ind., 21: No. 8, 110-11(Aug. 1962).

A nuclear pulse simulator for nuclear yields extending into the megaton range was developed. The simulator produces the characteristic shape of the thermal pulse from a nuclear detonation, which has a very rapid maximum on the order of μsec followed by a minimum and a slow maximum on the order of 4 sec after the blast. A gas discharge tube was used to achieve the very short rise time. The simulator circuit and its operation are described. (D.L.C.)

33175 EXTINCTION IN A PHOTO-ELECTRIC NUCLEUS COUNTER USING ADIABATIC EXPANSION OF 1.21 PRESSURE RATIO ACHIEVED BY INCREASING OR DECREASING THE ORIGINAL PRESSURE. L. W. Pollak and A. L. Metnieks (Dublin Inst. for Advanced Studies). Geofis. pura e appl., 49: 208-16(1962). (In English)

Comparisons were made of the extinctions as measured with a photoelectric condensation nucleus counter, Dublin School of Cosmic Physics Model 1957, when the over-pressure method or the under-pressure method with equal pressure expansion ratios were used for producing the adiabatic cooling of the sample in the fog-tube of the counter. Due to the Schlarb effect the extinction measured by the second method is smaller than that by the first. Tables and graphs for converting the extinction obtained by one method into that by the other are given. The advantages of the under-pressure method are given and discussed. (auth)

33176 MONITORING OCCUPATIONAL RADIATION EXPOSURE IN MEDICINE. Raymond E. Parks and Manuel Viamonte, Jr. (Univ. of Miami, Fla.). Ind. Med. Surg., 31: 284-6(July 1962).

The relative merits and disadvantages of the pocket dosimeter and the film badge for monitoring exposure in medical personnel are discussed, and it is concluded that the film badge is the only practical method for use with the types of ionizing radiation encountered in medical therapy and research. (H.H.D.)

33177 A METER FOR MEASURING THE MAGNETIC FIELD GRADIENT, CONSTRUCTED ON THE PRINCIPLE OF A SUPERREGENERATOR CONTROLLED BY NUCLEAR PRECESSION. E. P. Firsov, S. P. Pivovarov, and G. D.

Latyshev (Nuclear Physics Inst., Kazakhstan Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 1088-90(Aug. 1962). (In Russian)

With the presence of a small external emf of frequency ω close to the natural frequency ω_0 of a superregenerative circuit, coupling occurs and the phase of the natural oscillations Ψ varies as follows: $\Psi = \omega_0 t + (\omega - \omega_0)(2\pi m/\Omega)$. The Larmor nuclear precession can be introduced as an external synchronizing emf. Then, if ω_{lar} is close to ω_0, the superregenerative circuit frequencies will consist of: $\omega_{sr} = \omega'_{lar} \pm (\Omega/2 + n\Omega)$, where $\omega'_{lar} = \omega_{lar} + \Delta\omega$. The error $\Delta\omega$ is constant for a given circuit. If two superregenerative receivers are placed at different points on a field with strengths H_1 and H_2, the difference between the resulting frequencies is given by: $\omega'_{sr} - \omega''_{sr} = \gamma(H_1 - H_2) + \Delta\omega'$. A circuit is described that can be used to map a magnetic field. The results show that a difference in field strength of 10^{-3} to 10^{-4} of the measured field can be determined. The method is similar in principle to that presented by R. Freeman, in J. Sci. Instr., 38: 318(1961). (TTT)

33178 AN AUTOMATIC UNIT FOR MEASURING ELECTRON CONVERSION SPECTRA BY FEEDING AN ELECTRIC DISPLACEMENT TO THE SOURCE. I. M. Beskrovnyi, I. A. Kuragina, and A. Ya. Chezganova. Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 1090-2(Aug. 1962). (In Russian)

Stabilization of the magnetic field gradient on a $\pi\sqrt{2}$ spectrometer is difficult to achieve on changing the field strength. The field should be changed in small steps of not greater than 10^{-4} H_0. An electrical circuit was designed that selects the counting range, the size of the field displacement, and the counting time. The count is automatically recorded, the change in field is made, and the analysis is started again. The field is varied from −4 to + 4 kilovolts in steps of 2, 10, 50, or 100 volts. The stability is better than 1×10^{-4}. The minimum resolving time is 0.3 microseconds. The maximum capacity is 1.28×10^8 counts. The duration of the count is 15, 30, 60 sec, up to 64 minutes. The whole unit contains 262 transistors and 290 semiconducting diodes. (TTT)

33179 A UNIT THAT MEASURES THE GRADIENT OF A MAGNETIC FIELD. I. M. Beskrovnyi and P. T. Zabashta. Izv. Akad. Nauk SSSR. Ser. Fiz., 26: 1092-5(Aug. 1962). (In Russian)

Instruments which can measure the magnetic field gradient with an accuracy of at least 1% are required for various magnetic focusing systems. A simple method of measuring the field gradient is by means of a coil oscillating at constant amplitude prependicularly to the field. The outlet voltage from the measuring coil, oscillating sinusoidally along an axis x is given by: $V = nAx_0\omega(dB/dx)$, where n is the number of coil turns, A is the area of the coil, x_0 is the amplitude of the oscillations, ω is the angular frequency of the oscillations, and (dB/dx) is the magnetic field gradient. A device was constructed on this principle. The movable part of the system consists of a light paper tube (8 mm in diameter) with the measuring coil fastened to one end. The other end of the tube is coupled to a dynamic loudspeaker by means of two coaxial cones. A coil displacement of about 0.05 cm corresponds to a voltage to the amplifier inlet of $V = 2 \times 10^{-4}$ (dB/dx), where V is in volts, and (dB/dx) is the gradient in gauss cm^{-1}. The instrument gives a reading of the absolute value of the gradient. A stable amplifier made of semiconducting triodes is described. An expression is given for the effect of temperature on the amplification factor. Measurements can be made with an accuracy of 1% within a range of gradients of 0.02 to 5 gauss cm^{-1}. The instrument can be used to measure the field gradient along the radius of a $\pi\sqrt{2}$ magnetic β spectrometer with speed and accuracy. (TTT)

33180 MEASUREMENT OF SOLAR X-RADIATION. K. A. Pounds (Univ. of Leicester, Eng.). J. Brit. Inst. Radio Engrs., 22: 171-5(Aug. 1961).

The vertical-sounding Skylark rocket and the small Earth satellite, U.K.1, provide vehicles from which the short-wavelength solar x-ray emission may be studied under varying conditions of solar activity. Equipment was developed compatible with these relatively small vehicles, to provide a measure of the x-ray flux and the spectral shape in this very important and little-known part of the solar spectrum. (auth)

33181 COSMIC RAY MEASUREMENTS IN THE U.K. SCOUT I SATELLITE. H. Elliot (Imperial Coll. of Science and Tech., London), J. J. Quenby, D. W. Mayne, and A. C. Durney. J. Brit. Inst. Radio Engrs., 22: 251-6(Sept. 1961).

The main purpose of this experiment is to make accurate measurements of the primary cosmic ray energy spectrum and of the way in which this spectrum changes as a result of modulation by the interplanetary magnetic field. The cosmic ray intensity will be measured as a function of latitude and longitude using Geiger-Mueller counters, which respond to the total flux of primary particles, and a Cherenkov counter, which responds only to the heavy primaries with a charge of six or greater. An outline of the physical background to the experiment is given, together with a description of the sensor and its associated electronics. (auth)

33182 A NEW GAMMA RADIATION MONITOR. A. A. Luskow (Marconi Instruments Ltd., St. Albans, Hertfordshire, Eng.). J. Brit. Inst. Radio Engrs., 23: 217-23 (Mar. 1962).

An instrument for continuously monitoring the levels of gamma radiation in the vicinity of a nuclear reactor is described. The monitor employs transistors throughout except for an electrometer valve. Dose rates from 0.1 to 100 mr/hr are measured on a pseudo-logarithmic scale. (auth)

33183 PULSE COUNTING AND FAST SCALING TRANSISTOR CIRCUITS. F. H. Wells and J. G. Page (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Brit. Inst. Radio Engrs., 23: 231-5(Mar. 1962).

The present state of fast transistor scaling circuits is reviewed and typical designs given for: (1) a frequency divider stage for regular pulses; (2) aperiodic binary circuits for both slow and fast (100 Mc/p.r.f.) operation; (3) modification of a 4 binary scale-of-16 to a decade scaler operating at 10 Mc; (4) general purpose bistable plus AND gates circuits for use in pulse data processing applications as an add and subtract binary scaler or alternatively for gating pulse timing trains up to 8 Mc repetition rates. The present maximum repetitive pulse counting rates of scaler design is about 200 Mc but these rates may be exceeded with the use of faster transistors or tunnel diode circuits. (auth)

33184 THE IMPACT OF TRANSISTORS ON THE DESIGN OF REACTOR INSTRUMENTS. E. P. Fowler (Atomic Energy Establishment, Winfrith, Dorset, Eng.). J. Brit. Inst. Radio Engrs., 23: 495-500(June 1962).

The requirements of reactor instruments demand an unusual emphasis on the philosophy of fail to safety, guaranteed power supplies in all circumstances, and reliability over long periods of operation. The special advantages of transistors in the development of these instruments are simplicity of circuit and economy of power required. As a result, a greater emphasis can be placed on a-c or pulse

operation of circuits which, although inherently more complex, can be made much safer than d-c operation. New instruments designed for the UKAEA take their power from a d-c supply of 50 v center tapped or from the a-c mains which considerably eases the provision of stand-by facilities. A description is given of a logarithmic amplifier and period meter with a wide range, fast response, and no period overshoot which typifies the approach. A potentiometric recorder and pulse counting channel are briefly mentioned. (auth)

33185 RECORDING OF X-RAY QUANTUM FLUCTUATIONS IN RADIOGRAPHS. K. Rossmann (Eastman Kodak Co., Rochester, N. Y.). J. Opt. Soc. Am., 52: 1162-4(Oct. 1962).

When radiographic film is exposed with fluorescent intensifying screens, the spatial x-ray quantum fluctuations are recorded on the film as density fluctuations ("quantum mottle"). From the expression for the Wiener spectrum of the mottle, the standard deviation $\sigma_{D\ mottle}$ of the density fluctuations was derived in terms of certain screen-film parameters. It is shown that the Selwyn relation $\sigma_D d$ = const does not hold for quantum mottle. (auth)

33186 CALORIMETRIC CALIBRATION OF AN IONIZATION CHAMBER FOR DETERMINATION OF X-RAY TOTAL BEAM ENERGY. John S. Pruitt and Steve R. Domen. J. Research Natl. Bur. Standards, 66A: 371-80 (Sept.-Oct. 1962).

An x-ray calorimeter was used to determine the total energy transported by bremsstrahlung beams with maximum photon energies between 18.2 and 170 Mev. The measurements from two experiments were used to calibrate an aluminum ionization chamber for routine determinations of total beam energy. The calibrations are compared with calibrations of the same chamber made with a scintillation spectrometer, and with calorimetric calibrations made in other laboratories. (auth)

33187 THE USE OF THE PULSE FISSION CHAMBER FOR AUTOMATIC CONTROL OF REACTOR POWER AND PERIOD. Pavel Kovanic (Inst. of Nuclear Physics, Czechoslovak Academy of Sciences, Řež) and Ladislav Haniger. Jaderná energie, 8: 221-4(July 1962). (In Czech)

The use of pulse fission chambers for automatic control of reactor power and period was verified. The use of such indicators enables full and reliable suppressing of the influence of gamma radiation on the control system operation even in the most unfavorable operation conditions, and also enables the remarkable extension of the operational range of the control system. (auth)

33188 AN INSTRUMENT FOR THE MEASUREMENT AND ANALYSE OF AIRDUST RADIOACTIVITY. W. Schroeck-Vietor (Kernforschungsanlage, Jülich, Ger.). Kerntechnik, 4: 372-6(Sept. 1962). (In German)

For measuring and analyzing the airdust radioactivity an instrument with a step by step moving filtertape and three detectors is used. The dust collecting period comes to three hours between the steps. The radioactivity is measured three times: during the collection, after the collection and after a delay period of four days. The detector measures the half life time which allows that shortly after the collection the longliving radioactivity can be determined. Compared with the usual instruments with continuously moved filtertapes, the above described instrument is able to give additional information concerning the airdust radioactivity. (auth)

33189 STUDY OF GADOLINIUM FILTER FOR THE NEUTRON TEMPERATURE MEASUREMENT. Eiichi Arai (Tokyo Inst. of Tech.) and Ryozo Yumoto. Nippon Genshiryoku Gakkaishi, 4: 519-25(Aug. 1962). (In English)

For the study of the low-energy neutron spectrum by the integral method, it is important to develop sensitive neutron temperature detectors. The non-$1/v$ property of the effective cross sections of Pu^{239} or Lu^{176} has been used for this purpose. If the non-$1/v$ property of the neutron detector is varied artificially, a very useful technique for the study would be obtained. Gadolinium has a large absorption cross section in the low energy region; the cross section decreases rapidly with increase of neutron energy. Thus, the neutrons filtered through a Gd foil will be devoid of the low energy part in the spectrum. It would be sharply cut off at the energy of 0.1 to 0.5 ev. With this sharp cut-off filter, the shift of Maxwellian distribution of thermal neutrons would be detected very precisely. Two BF_3 counters were located at the same geometries. One of them was bare and the other was covered with the Gd filter. The ratio of their count rates will be defined as the Gd ratio and is very sensitive to the neutron temperature. The neutron temperatures were varied by re-thermalization in a water tank at different temperatures. The pure Maxwellian thermal neutrons were introduced into the tank from the thermal column of the JRR-1 reactor. The temperature of the tank was varied very slowly between the range of 15 to 85°C. The resolving power of the neutron temperature detector was found to be 2°C. (auth)

33190 INSTRUMENTATION FOR TEST-RIGS. 3. HIGH-PRESSURE LOOP EXPERIMENTS. T. Hayes and D. Walmsley (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nuclear Power, 7: No. 78, 49-53 (Oct. 1962).

The requirements for instrumentation of high-pressure experimental loops are reviewed on the basis of several years' experience with aqueous loops. Methods and techniques are discussed for pressure control and measurement, temperature control and measurement, flow measurement, liquid level indication, leak testing, analytical control, inspection, and safety. (D.L.C.)

33191 IN-LINE RADIOMETRIC PROCESS MONITORS. Part 3. H. Bisby, F. D. Seymour, G. F. Snelling, and J. H. Wilkins (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nuclear Power, 7: No. 78, 66-70 (Oct. 1962).

The design of a process monitoring system for chemical separation plants is described. The detector assemblies are located in relatively unshielded areas and controlled by an Intermediate Instrument Station, while the pulse-rate information is presented in a remote Instrument Control Center. The pulse-handling system and the detector system are described in some detail. Results of tests carried out in the Windscale Plant are described briefly. (D.L.C.)

33192 MULTICHANNEL ANALYZERS IN SPACE. Jay R. Wolff and Ralph M. Ravanesi (Radiation Instrument Development Lab., Inc., Melrose Park, Ill.). Nucleonics, 20: No. 10, 58-60(Oct. 1962).

Miniaturized multichannel analyzers were developed which approach the sophistication of laboratory analyzers. The miniaturized analyzers are of two types: multidiscriminator (multiple single-channel or integral) and pulse height-to-time. Present configurations of each type are described. The requirements for future space-going multichannel analyzers are discussed. (D.L.C.)

33193 NUCLEAR MISSIONS IN PROGRESS. RANGER GAMMA-RAY SPECTROMETER. Albert E. Metzger (Jet Propulsion Lab., Pasadena, Calif.), Marvin A. Van Dilla,

Ernest C. Anderson, and James R. Arnold. Nucleonics, 20: No. 10, 64-6(Oct. 1962).

Ranger 3 and 4 spacecrafts carried spectrometers for detecting gamma rays from naturally radioactive elements (K, U, and Th) in the moon surface. The spectrometer comprises a CsI(Tl) crystal-phototube detector combination, a high-voltage power supply, and a multichannel pulse-height analyzer. The tests carried out on the spectrometer and its operation are described. Ranger 3 missed the moon, but some data for gamma-ray astronomy were obtained. Ranger 4 impacted the moon but failed to transmit any data. (D.L.C.)

33194 ANALYZING THE MOON'S SURFACE. Carlton D. Schrader (Aerospace Corp., El Segundo, Calif.), James A. Waggoner, Albert E. Metzger, and Jerry H. Zenger. Nucleonics, 20: No. 10, 67-8(Oct. 1962).

A prototype instrument was developed for using neutron bombardment to analyze the lunar surface after a soft landing. A miniature accelerator will be used to produce neutrons for bombarding the surface, and the resulting gamma rays will be detected and recorded for telemetering back to Earth. Both the chemical composition and density of the lunar surface can be determined in this way. (D.L.C.)

33195 COSMIC-RAY DETECTION AND ANALYSIS. Nucleonics, 20: No. 10, 70(Oct. 1962).

A scintillation-counter telescope for measuring the spectra of cosmic rays is described. It is to be used in the NASA Orbiting Geophysical Observatory. Another telescope is described which has only one photomultiplier tube and can measure over the energy range 50 to 500 Mev. (D.L.C.)

33196 BODY Na^{24} ACTIVITY AS A MEASURE OF NEUTRON DOSE. Edwin R. Ballinger, Payne S. Harris, Lee Carr, Richard Hiebert, and John Larkins (Los Alamos Scientific Lab., N. Mex.). Nucleonics, 20: No. 10, 76, 78, 80, 82, 85(Oct. 1962).

A procedure for estimating the neutron dose was developed which involves only external measurements of a neutron-induced activity. A two-unit probe-and-meter assembly was designed, the probe being a NaI crystal coupled to a photomultiplier tube and the meter assembly being calibrated to correct for Na^{24} decay and to read in rads of neutrons when the probe is held against the lumbar area of the back. The ratio of Na^{24} activity to Cu^{64} found in coins, buckles, or foils worn by the exposed person is used to estimate the incident neutron energy. The problems and limitations of the procedure are discussed. (D.L.C.)

33197 TRANSMISSION TIME EXPERIMENTS ON PHOTOMULTIPLIER TUBES. Guenter Marx and Guenter Sauerbrey (Technische Universität, Berlin). Nukleonik, 4: 208-13(July 1962). (In German)

The transmission time of electrons in a multiplier was determined from the phase displacement which undergoes a sinusoidal signal during its transmission time. The starting phase at the cathode is shown by variation of the operating voltage U_{ges} and extrapolation to $U_{ges} \to \infty$. The transmission time is inversely proportional to the square root of the operating voltage U_{ges}. In the same manner the transmission time of the photoelectrons between cathode and the first dynode was determined for several multiplier types. The transmission time profile of the cathode could be traced by scanning the photocathode with the reduced beam of the source light. Transmission time differences up to 15 nsec can then be obtained. By means of the transmission time expansion in the multiplier, explanations on amplification fading at high frequencies are given. The width of the expansion produced in the dynode cascade was determined. Since the expansion was principally produced by distinct output velocities of the secondary electrons, it is inversely proportional to the voltage on the dynode cascade. (tr-auth)

33198 THE CRACOW NEUTRON CRYSTAL SPECTROMETER. Szezęsny Krašnicki, Jan Pawelczyk, and Henryk Rapacki (Jagiellonian Univ., Krakow). Nukleonika, 7: 223-30(1962). (In English)

The construction of a universal double axis crystal neutron spectrometer is described. The parameters of the instrument are given with some illustrative results. Its application as a triple axis spectrometer is discussed. The instrument was designed for cross-section and diffraction measurements and investigations of inelastic scattering of neutrons in crystals. (auth)

33199 A TIME OF FLIGHT SPECTROMETER FOR SLOW NEUTRONS. Tadeusz Niewiadomski, Antoni Szkatula, and Jan Sciesiński (Inst. of Nuclear Physics, Krakow). Nukleonika, 7: 231-44(1962). (In English)

A time-of-flight spectrometer for slow neutrons with a planar slit chopper and a 10 channel time analyser was constructed. The spectrometer is designed for total cross section measurements in thermal and sub-thermal energy region. The energy analysis is possible in the energy interval from 0.002 ev to ca 1 ev at the resolving power 13.2, 6.6, or 3.3 μsec/m. The minimal error of energy E is 1.5%. The parameters of the chopper are: the height of the slits — 1.5 mm; diameter of the rotor — 120 mm; and rotations per sec: 25, 50, and 100. The parameters of the time analyser: channel widths: 10, 20, 40 and 80 μsec; and delay — from 0 to ca 14 msec. Test measurements were made at the reactor channels 5 and 6 of the Polish reactor EWA. The neutron spectrum was measured and the results were compared with the Maxwellian distribution for the temperature of 335°K. The cross section of silver was determined and compared with the data of Neutron Cross Sections Tables and with the measurements performed with the crystal neutron spectrometer, transmission through Al and Be was measured, and the obtained local maxima were compared with the cut off values corresponding to the Bragg scattering. (auth)

33200 LIGHT CHAMBER OR GAS-AMPLIFIED SCINTILLATION CHAMBER. C. Cavalleri, E. Gatti, and G. Redaelli (CISE, Milan). Nuovo Cimento (10), 25: 1282-91(Sept. 16, 1962). (In English)

A gas detector is realized and developed. The detector can furnish a luminous image of the track of an ionized particle if isotropic properties are realized within the chamber volume, in such a way as to retain information on the direction, range, and ionization density. Operation is based on the decay of excited states caused by secondary electrons obtained by Townsend local multiplication of the primary electrons along the track. The multiplication is obtained via application of a damped radiofrequency electric-field oscillation, which is produced by a pulse generator triggered by a multiplier phototube that is sensitive to the primary scintillation. A typical photograph is shown of the tracks of α particles obtained with such an instrument. The light intensity obtained restricts use to particles characterized by high ionization density. (auth)

33201 DISTRIBUTION OF THE ABSORBED DOSES FROM A HOLLOW CYLINDRICAL RADIATION SOURCE. E. E. Kovalev, V. I. Popov, and L. N. Smirennyi. Radiobiologiya, 2: 502-7(1962). (In Russian)

Gamma sources are usually prepared by arranging the radioactive preparation alongside the generatrix of a hollow cylinder; determination of the distribution of the

dose absorbed by a cylindrical body from such source is of great interest. Solution of this problem was carried out on the basis of assumptions published by the authors in a previous paper (Radiobiologiya 1: 807 (1961)). The derived data allowed construction of nomographs for determining the distribution of the absorbed dose at any desired section of the object. The distribution of the dose alongside any line parallel with the axis of the cylinder varies only slightly within the height of the object, being reduced at most by a factor of 2; however, it changes suddenly in the radial direction, being a function in that case of the absorbing properties of the object. The calculations made it simple to determine the conditions of irradiations; in most cases it is sufficient to know only the ratio of the maximum and minimum doses. Multiple scattering of x rays increases the local absorbed dose without affecting too strongly the dose distribution. The calculated values agree with experimentally obtained data within 10%. (TTT)

33202 SEMICONDUCTOR PARTICLE-DETECTORS. Olexa-Myron Bilaniuk. Sci. Am., 207: No. 4, 78-84; 86; 88(Oct. 1962).

The characteristic performance of semiconductor detectors is reviewed and compared with that of ionization chambers. Their advantages are small volume, rapid response, and ability to resolve particles with similar energies; their disadvantages are dark current and polarization. Surface-junction and surface-barrier counters are excellent for detection of multiply charged fragments, such as fission fragments. Fabrication techniques and recent developments in semiconductor detectors are reviewed. (D.L.C.)

33203 ACCURACY AND REPRODUCIBILITY OF COUNTING RATES (MEASUREMENTS WITH GEIGER-MÜLLER TUBES). H. Erbe. Telefunken Ztg., 35: 7-11 (Mar. 1962). (In German)

The accuracy with which measurements can be made with series-connected Geiger-Mueller tubes and counters under normal laboratory conditions was studied. The following points were investigated: changes of the tube characteristics during 2×10^8 counts, extent of the counting rate deviation if 10^6 pulses are counted each time, the possibility of aftereffects being caused in the tube as the result of very intensive radiation, and warming-up duration after cold equipment is switched on. The results were shown graphically. (auth)

33204 RATE METER WITH LINEAR AND LOGARITHMIC SCALES. G. Boucke. Telefunken Ztg., 35: 12-19 (Mar. 1962). (In German)

The determination of the activity of a radioactive sample is based essentially on a frequency measurement. For this purpose rate meters or digital counters are used. In the present paper, count rate meters used preferably for the observation of continuously variable counting rates are described. The requirements with respect to measurement scope and scale range vary greatly, with ranges of five decades often being desired for monitors. The three most commonly used types are described: rate meters with linear scale, rate meters with compressed, approximately logarithmic scale, and rate meters with strictly logarithmic scale. After this general review, the rate meter developed by Telefunken is described. (auth)

33205 THE PULSE PROPERTIES OF SCINTILLATION PROBES WITH NaI(Tl) CRYSTALS. K. Fraenz and Kl. Mueller. Telefunken Ztg., 35: 24-37(Mar. 1962). (In German)

Theoretical and experimental investigations of scintillation pulses generated by probes containing NaI(Tl) crystals are outlined. Emphasis is given to the pulse statistics by which the energy and time resolution of gamma spectrometers using these crystals is determined. (auth)

33206 A FLAT NEUTRON MULTIWIRE COUNTER. P. N. Vyugov, V. S. Dementi, and V. S. Poryatuii (Inst. of Physics and Tech., Academy of Sciences, Kharkov). Ukr. Fiz. Zh., 7: 618-22(June 1962). (In Ukrainian)

Description is given of a neutron counter, cylindrical in shape, 32 mm high, and 112 mm in diameter. It is made of copper sheets 0.5 mm in thickness and has a 150 v plateau region and stable operation in the range of −4 to −12 v. The developed neutron multiwire counters are not sensitive to 4 mC gamma radiation at a distance of 20 cm. The neutron counter readings are constant at a temperature range between 10 and 60°C; then they decrease and at 100°C equal ~50%. (auth)

33207 A POLYGONAL MAGNETIC ANALYZER AND MULTIPLE SPECTROGRAPH. V. A. Blinov, I. O. Konstantinov, V. F. Litvin, and Yu. A. Nemilov. At. Energ. (USSR), 13: 59-60(July 1962). (In Russian)

Polygonal magnetic analysis represents a good method for determining the angular distribution of nuclear reactions as it requires small amounts of materials and can be carried out in a short time. A previously built multiple spectrograph (Yu. A. Nemilov and V. F. Litvin, Pribory i Tekhnika Eksperimenta, 32: (1960) No. 2) was operated in a Van de Graaff accelerator. The magnetic field created by a permanent magnet could be adjusted up to 7×10^3 oersted. Diaphragms corresponding to the particle emission angles were placed in a sawtooth arrangement at the boundary of the magnetic field. Each diaphragm corresponds to a body angle of $\Omega \approx 3 \times 10^{-4}$ steradian within its own spectrograph. The cassettes holding the nuclear emulsion can be adjusted to any desired position for the purpose of recording particles of a given energy. The light intensities of the channels were compared with each other by the juxtaposition of the 2.55-Mev protons, elastically scattered on a Au target. (TTT)

33208 A PULSED ION SOURCE WITH LOW GAS CONSUMPTION. I. I. Afanas'ev, A. S. Knyazyatov, and N. D. Fedorov. At. Energ. (USSR), 13: 135-9(Aug. 1962). (In Russian)

Certain types of investigations require the use of a pulsed hydrogen ion source having a low pulse frequency, high beam intensity, and low gas consumption. On the basis of the work of K. Ehlers et al. (Rev. Scient. Instrum., 29: 614 (1958) No. 7) involving sources with occluded gases, two types of Ti sources with deuterium-saturated electrodes were developed. Measurements with Faraday cups showed that the deuteron beam current on a collector placed at 120 cm from source reached 10 ma; the gas consumption per pulse which lasted for about 500 μsec, was found to be 10^{-3} cm^3. A two-electrode system was developed for focusing the beam. It was found that a rate of several pulses per minute can be maintained. About 15% protons were present in the beam; this is probably due to gases removed from the walls of the discharge chamber. (TTT)

33209 THE PROPAGATION OF THE DISCHARGE IN SELF-QUENCHING COUNTERS. [PART] II. Guenter Franke and E. Huster (Universität, Munster, Ger.). Z. Physik, 168: 567-73(1962). (In German)

It is somewhat difficult to fill GM counters having different wall materials with exactly the same gas mixtures because of the different adsorption by the walls. If, however, the mixtures do not differ, the Geiger thresholds do not depend on the material of the walls within the sources of errors. (We investigated cathodes of brass, copper, aluminium, selenium, copper oxide, and sulfide.) From this it

cannot be concluded whether the discharge travels along the counter by photoelectric effect in the gas or at the wall. The latter is possible because the photoelectric qualities of the wall could depend only on the adsorbed gas layers. With selenium as cathode the plateau is more than 100 volts shorter than with the other materials. Measurement of the statistics of the traveling time of the discharge along counters showed distinct maxima which, according to the results of Lauterjung and Vater, can be interpreted in favor of the hypothesis of Huster and Ziegler that the discharge spreads over the wall. (auth)

33210 DAS GEIGER-ZÄHLROHR UND ANDERE STRAHLENNACHWEISGERÄTE. (The Geiger Counter and Other Nuclear Radiation Detection Instruments). Rudolf Weibrecht, ed. Leipzig, Veb Deutscher Verlag für Grundstoffindustrie, 1960. 91p.

The discovery and properties of radiation and the development of the Geiger counter are reviewed. A survey of modern detection apparatus is presented. Physical considerations of the process of ionization are discussed. Gas discharge as a function of pressure is considered. The ionization chamber, proportional counter, and Geiger-Mueller counter are described. Errors in and corrections for counter measurements are outlined. Directions are given for work with counters. (M.C.G.)

33211 UZLY NOVOY APPARATURY DLYA ISSLEDOVANIYA YADERNYKH IZLUCHENII; NAUCHNO-TEKHNICHESKII SBORNIK. (Units of New Apparatus for Investigating Nuclear Radiations; Scientific and Technical Collection). No. 2. V. S. Zhernov and D. P. Shirshov, eds. Moscow, Gosatomizdat, 1961. 149p.

Sixteen articles are included on the problems and applications of semiconductor triodes in scintillation counters and on devices for recording and investigating nuclear emissions. New scintillation transducers, gaseous scintillation counters, neutron dispersion detectors, and spectrometric γ transducers are described. Separate abstracts have been prepared for 9 articles. (R.V.J.)

33212 SEMI-CONDUCTOR TRIODE CALCULATION SCHEMES. A. A. Bogdanov, L. S. Gorn, and B. I. Khazanov. p.7-22 of "Uzly Novoy Apparatury Dlya Issledovaniya Yadernykh Izluchenii." Moscow, Gosatomizdat, 1961.

Semiconductor triode triggers with crossing resistivity bonds, transistor triggers, and ferrite cores with rectangular hysteresis loops used in pulse analyzer conversion schemes are described. Diagrams of decade, high-resolution calculation schemes, binary stepping conversion schemes, and annular stepping-conversion schemes are included. (R.V.J.)

33213 DIFFERENTIAL COUNTING SEMICONDUCTOR TRIODE SCHEME. A. A. Bogdanov, L. S. Gorn, and B. I. Khazanov. p.32-47 of "Uzl, Novoy Apparatury Dlya Issledovaniya Yadernykh Izluchenii." Moscow, Gosatomizdat, 1961.

A differential counting, semiconductor triode scheme for analyzing pulses from two transducers and using an ordinary (non-reversing) counting device, based on two pulses entering in two n_1 and n_2 entrances with a certain differential sequence n_p (where the number of pulses is equal to the difference in the number of signals entering each entrance, $n_p = n_1 - n_2$), is suggested. (R.V.J.)

33214 ERROR IN COUNTING DEVICE. L. S. Gorn, A. E. Zabelin, and B. I. Khazanov. p.48-52 of "Uzly Novoy Apparatury Dlya Issledovaniya Yadernykh Izluchenii." Moscow, Gosatomizdat, 1961.

An analysis is made of the error in a previously suggested differential counter scheme based on adding and subtracting information from a two-trigger scheme. (R.V.J.)

33215 ON THE OPERATION OF TRANSISTORIZED CORRELATED CASCADES IN SCINTILLATION SPECTROMETER TRANSDUCERS. L. S. Gorn and B. I. Khazanov. p.61-7 of "Uzly Novoy Apparatury Dlya Issledovaniya Yadernykh Izluchenii." Moscow, Gosatomizdat, 1961.

An analysis was made of the peculiarities of semiconductor devices caused by applied cut-off intensity. The effect is well observed in the cascade scheme used for connecting a multiplier with an analyzing scheme. (R.V.J.)

33216 A DEVICE FOR RECORDING STRONG X-RADIATION FROM STRONG PULSE DISCHARGE IN GAS. V. V. Matveev and A. D. Sokolov. p.101-6 of "Uzly Novoy Apparatury Dlya Issledovaniya Yadernykh Izluchenii." Moscow, Gosatomizdat, 1961.

Descriptions are given of an assembly for recording the energy and time distribution of hard x radiation emitted during strong pulse discharge in gases. (R.V.J.)

33217 INTERMEDIATE ENERGY NEUTRON DETECTOR. V. S. Filonov and Yu. P. Sel'dyakov. p.107-10 of "Uzly Novoy Apparatury Dlya Issledovaniya Yadernykh Izluchenii." Moscow, Gosatomizdat, 1961.

The dependence of neutron detector efficiency on the energy and intensity of the γ background was analyzed for a detector using a FEU-24 photomultiplier. (R.V.J.)

33218 DOUBLE-CRYSTAL SPECTROMETER WITH SUMMING COMPTON DISTRIBUTION. L. S. Gorn, G. S. Emel'yanova, and B. S. Khazanov. p.111-23 of "Uzly Novoy Apparatury Dlya Issledovaniya Yadernykh Izluchenii." Moscow, Gosatomizdat, 1961.

An attempt was made to analyze complex spectra by summing Comptom spectra. As many identical Compton distributions were developed from an organic phosphor and from a sodium iodide crystal as possible. Experiments at 0.1 to 1.5 Mev showed good results, while with large sodium iodide crystals the experiments were not successful. (R.V.J.)

33219 INSTALLATION FOR CHECKING GAS SCINTILLATION COUNTERS. S. A. Baldin and V. V. Matveev. p.124-30 of "Uzly Novoy Apparatury Dlya Issledovaniya Yadernykh Izluchenii." Moscow, Gosatomizdat, 1961.

A gas scintillation counter, with auxiliary pumping and filtering, for recording nuclear emissions was tested in xenon with Po^{210} emitting 100 α particles per second. The maximum pulse amplitude for Co^{60} γ emission was about 10-fold less than for Po^{210}. (R.V.J.)

33220 SPECTROPHOTOMETER SF-4 IN DEVELOPING SCINTILLATION COUNTERS. S. A. Baldin, V. V. Matveev, and A. D. Sokolov. p.131-7 of "Uzly Novoy Apparatury Dlya Issledovaniya Yadernykh Izluchenii." Moscow, Gosatomizdat, 1961.

Descriptions are given of a spectrophotometer (SF-4) with a specially designed chamber (800 mm in diameter and 300 mm high) for optimum geometry. (R.V.J.)

33221 NUCLEAR ELECTRONICS. VOL. III. Proceedings of the Conference on Nuclear Electronics Held at Belgrade, 15-20 May 1961. (International Atomic Energy Agency, Vienna). Proceedings Series. Apr. 1962. 540p. (STI/PUB/42(Vol. III)). $11.00(IAEA).

Forty-seven papers and one abstract were published in this volume of the Proceedings. Five papers have previously been abstracted in NSA. The remaining forty-two papers were abstracted separately, and the abstracts appear below. (L.T.W.)

33222 PULSE-AMPLITUDE DISCRIMINATOR AND 200-MHz SCALE. J. P. Duchemin and J. Mey (Centre d'Études Nucléaires, Grenoble, France). p.15-18 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In French)

A device consisting of a pulse-amplitude discriminator and a scale of 8, with a resolving time of 5 ns, is described. The threshold, adjustable from 1 to 11 v, is designed for positive input pulses by means of a cathode-coupled threshold amplifier, using high figure of merit tubes and conveniently compensated for fast pulses. The two first flip-flops are of the slave type, and each one is composed of a bistable circuit associated with a driving switch circuit. Some amplifying and shaping circuits are introduced between the different stages. (auth)

33223 TUNNEL AND PNPN DIODES IN FAST ELECTRONICS FOR DISCRIMINATION AND COUNTING DEVICES IN NUCLEAR PHYSICS. G. Verroust and C. Victor (Laboratoire Joliot-Curie de Physique Nucleaire, Orsay, France). p.19-27 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In French)

With a simple apparatus without power supply, the rise time of the pulse produced by the fast switching of a tunnel diode was measured. This time was of the order of 0.5 ns. The addition of a source of current made it possible to mount an ultra-fast amplitude-discrimination trigger working at a nanosecond. Problems of power supply and impedance adaptation make this a delicate experiment to perform successfully. It is particularly difficult to get good trigger threshold stability, as this is very sensitive to the supply voltage. At the present stage of the technique, a bistable flip-flop utilizing only one tunnel diode does not offer the operational security which would permit its use in nuclear physics. But it is possible to construct bi-stable flip-flops with two tunnel diodes. A system of n tunnel diodes in series, fed by a constant-current generator, presents n potential stable states. It is therefore possible to construct fast scalers of astonishing simplicity. Unfortunately, up until now zeroing has required the use of slower active or passive elements which do not allow full use to be made of the scaler's capacity. Combinations of tunnel diodes make it easy to construct rather complex electronic commutators. The difficulty of using tunnel diode circuits lies essentially in problems of power feed and in linking them with other electronic gear. Nevertheless, their very considerable advantages justify intensive study in order to render them simple to use. With four-layer diodes similar apparatus, but capable of furnishing considerable power, can be constructed. However, they require high voltages to justify their use in electronic tube circuits. (auth)

33224 THE TUNNEL DIODE AS A THRESHOLD DEVICE: THEORY AND APPLICATION. G. Infante and F. Pandarese (Comitato Nazionale per l'Energia Nucleare, Frascati, Italy). p.29-40 of "Nuclear Electronics." Vol. III." Vienna, International Atomic Energy Agency, 1962. (In English)

Due to the interesting properties of the tunnel diode, the device is extensively studied concerning its circuit behavior. An empirical formula, approximating the diode's V-I characteristics, has been obtained. This allows calculations of rise time, delay time, jitter, etc., to be carried out in certain instances; theoretical predictions based on this approximation are in good agreement with experimental results. Stability considerations and curve-plotting circuits are also studied. A high-speed discriminator-coincidence circuit using transistors and tunnel diodes is presented. (auth)

33225 AMPLITUDE-MEASURING DEVICES FOR ELECTRIC PULSES IN THE NANOSECOND REGION. J. J. Samueli and A. Sarazin (Institut d'Études Nucléaires, Algiers). p.41-8 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In French)

Two electronic circuits are described which permit measurement of the maximum amplitude of fast pulses. These circuits are usually required, if possible, to give independent indication of the duration and shape of the signal being studied. The first circuit is a pulse expander, i.e., an apparatus for converting fast signals into pulses of constant width and of amplitude proportional to the amplitude sought, thus permitting the study of fast signals with a conventional amplitude selector. The circuit can accept signals of width greater than two nanoseconds and of amplitude between 1 and 15 v. It delivers two signals of constant width 100 ns and 1 μs. The second circuit is a fast amplitude-discriminator with an adjustable threshold from 1 to 30 v and a reading space of approximately 18% for pulses of 100 and 2 ns. The output signal has an amplitude of 1.5 v and a standard width of 0.2 μs. (auth)

33226 A MULTI-CHANNEL COINCIDENCE CIRCUIT WITH SHORT TIME INTERVALS. M. Bysochanskii, S. V. Mukhin, et al. p.49-58 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In Russian)

A diode-coincidence circuit with short time intervals is described. Working scintillation counters and a three-channel coincidence circuit with 100% efficiency, a resolving time $\tau = 1.8$ ns was obtained and a time interval (half-width of the coincidence curve at 0.1% N_{max}) $\tau 0.1 = 3.5$ ns. The dead time of the coincidence circuit (for coincident pulses) is 300 ns. The circuit operates from negative pulses of amplitude $\geq$500 mv. (auth)

33227 THE RESOLVING LIMIT OF A THREE-DIODE COINCIDENCE CIRCUIT. H. de Vries (Universität, Marburg, Ger.). p.59-69 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In English)

To investigate the resolving limit of a three-diode coincidence circuit according to De Benedetti and Richings, a complete coincidence device, consisting of diode stage, amplifier, amplitude discriminator, and univibrator, was tested with pulses of 10^{-9} s risetime and 2×10^{-9} s basal duration. The amplitudes were measured and also the integrals of the pulses received at the amplifier output as well as the resolution curve dependent on the interesting parameters—amplitude of the input pulses, input resistance of the amplifier, operating conditions of the diodes, etc. In order to explain the measurements, certain investigations were made. The resolution curve of the coincidence device was deduced and the resolving time calculated. It was calculated how the diode stage, the amplifier noise and the matching of the amplifier to the diode stage determine the resolving time of the coincidence device. An analysis of the measurements and theoretical results yielded 10^{-11} s as the lowest resolving time-limit which can be realized with a three-diode coincidence device under optimum conditions. The derivation of the resolution curve is given and the measurements are reported. It is shown that experimental and theoretical results are in good agreement. (auth)

33228 A DIFFERENTIAL NANOSECOND RANGE TIME-AMPLITUDE CONVERTER. F. Tintă (Inst. of

Atomic Physics, Bucharest). p.71-80 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In French)

The apparatus was designed for time analysis of nuclear events in the nanosecond range, especially for fast-neutron spectrometry by the time-of-flight method and for determining excited level life-times of the order of 10^{-9} s. The circuit comprises two conversion sections employing 6BN6 tubes and shifted with respect to each other by a time interval of 32 ns. The outputs of these conversion sections (as well as the control outputs of the counters) are combined in a slow coincidence circuit, which controls a gate and thus permits differentiation of the negative and positive time intervals in relation to a given reference event. This method not only gives a reduction of 50% in the counting rate of random coincidences, but also makes it possible to check in the total number of these coincidences and to employ the pulsed-beam method in the nanosecond range. The conversion is practically linear over a range of 25 ns. The apparatus may also be used as a coincidence circuit with variable resolving time between 3 and 30 ns. By means of two counters employing FEU-33 photomultipliers and NE102 scintillators, a resolving time of better than 3 ns was obtained with good stability. (auth)

33229 A TIME SELECTOR FOR ANALYZING PULSE TRAINS. V. G. Brovchenko and Yu. D. Molchanov (Kurchatov Inst. of Atomic Energy, Academy of Sciences, USSR). p.81-6 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In Russian)

The selector is intended for measuring the time distribution of pulses in pulse trains. The minimum channel width is 20 μs. The clearance between channels is 2 μs. The maximum length of trains that can be dealt with is practically unlimited. Thanks to the short resolving time in recording (3×10^{-8} s), the equipment can be used for studying single, non-recurring processes. A signal similar in shape to the distribution curve is produced with the aid of a periodically discharging capacitor storage device and is photographed on the screen of the oscilloscope. (auth)

33230 LINEAR CAPACITY STORAGE DEVICES. V. G. Brovchenko (Kurchatov Inst. of Atomic Energy, Academy of Sciences, USSR). p.87-92 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In Russian)

The linearity of information storage in capacitor storage circuits is discussed. The paper describes two storage circuits whose operation is linear over a wide range of output-signal amplitudes. In one of the circuits the error signal is measured by a differential amplifier and, thanks to the high amplification factor of the amplifier, good linearity is obtained. The second circuit was designed for work in the nanosecond pulse-width range. Input pulses of standard width cut off a pentode, in the anode of which there is a memory capacitor. Since the capacitor is charged from the anode supply through a current generator, the charging current remains almost constant during measurement of the capacitor voltage. The pentode has a large internal resistance so that after the end of the input pulse the magnitude of the current through the pentode is almost equal to its initial value, and the charge stored by the capacitor is remembered. The width of the information memory is limited by the output resistance of the current generator and the internal resistance (R_i) of the pentode. To increase the memory width, a diode may be inserted before the capacitor. (auth)

33231 A NOVEL TIME-TO-PULSE HEIGHT CONVERTER FOR FAST-NEUTRON TIME-OF-FLIGHT TECHNIQUES. J. Christiansen (Physikalisches Staatsinstitut, Hamburg). p.93-7 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In English)

An electronic time-to-pulse height converter is described which uses a multiplicative method instead of the usual one of adding overlapping pulses. This is achieved by a coincidence of a linear sawtooth and a sharply clipped needle-pulse. The sawtooth is fed to the grid of a beam-deflecting tube (E80T) and the needle-pulse is applied to the deflecting plates and opens the tube only during a time-interval of about 5.10^{-9} s. The plate gets a charge proportional to the time-difference between the start of the sawtooth and the needle-pulse. The plate-pulse is stretched and amplified and its height represents a measurement of the time-difference. With this method a time resolution of $2\tau = 7 \times 10^{-12}$ s with artificial pulses, $2\tau = 3 \times 10^{-10}$ s with Co^{60} γ-coincidences by using NE 102 plastic crystals, and $2\tau = 1.4 \times 10^{-9}$ s with 511-kev γ-coincidences using NaI(Te) crystals was obtained. The method was also used with pulsed beam techniques. A time resolution of $2\tau = 1.1 \times 10^{-9}$ s with 4-Mev neutrons using plastic crystals 0.7 in. long was obtained. Normally the region of linear response was 30 ns but it was possible to go up to 120 ns. (auth)

33232 FAST TRANSISTORIZED TIME-AMPLITUDE CONVERTER. J. C. Brun, R. Brueil, and C. Victor (Faculté des Sciences de Paris, Orsay, France). p.99-103 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In French)

A time-amplitude conversion circuit in the 10^{-10} to 10^{-8} range, utilizing wide-band transistors, is described. This circuit can be used to measure short periods in gamma spectrometry. (auth)

33233 A FAST COINCIDENCE WITH SLOW SCINTILLATORS. E. Gatti, F. Vaghi, and E. Zaglio (Centro Informazioni Studi Esperienze, Milan). p.105-11 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In English)

As is well known, a time measurement may be obtained by using the zero crossing of a bipolar pulse linearly derived from the multiplier phototube. The bipolar pulse, coming from a double-line amplifier, is sent to the coincidence channel and the amplitude measurement is made by means of the first part of the pulse. In order to reduce statistical spreading at the time of the zero crossing, the pulse is so shaped that the zero crossing has the statistical properties of the collection time of a small fraction of total photo-electrons. The circuit is derived from one recently developed by R. Chase and is used both for amplitude and time-measurement. The systematic error of time measurement is a few nanoseconds for an amplitude-variation of a factor ten of the input bipolar pulse; the statistical spreading for pulses derived from 500-kev rays is six nanoseconds. (auth)

33234 ULTRA-HIGH-SPEED OSCILLOGRAPHIC TECHNIQUES. S. Abercrombie, B. Elphick, and H. Foster (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). p.115-44 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In English)

After a brief history of high-speed transient oscillograph technique, the practical limitations are discussed. A survey of suitable cathode-ray tubes is presented with particular reference to traveling-wave deflection types. The following components of a complete transient signal oscillograph are dealt with: (a) A traveling-wave (TW) deflector cathode-ray tube with balanced co-axial connection, and a bandwidth of

2 BHz; (b) A phase-splitting transformer of 100 and 50-Ω characteristic impedance and a bandwidth of 1.5 kHz to 1.5 BHz, (c) Co-axial terminating resistors with BHz performance; (d) Coupling capacitors, compensated for inclusion in co-axial lines for the frequency range 5 kHz–3 BHz, with characteristic impedances of 100 Ω; (e) Wide band resistive pads for the extraction of timebase triggering signals; (f) Nanosecond timebases with triggering and blanking facilities; (g) A wide-aperture camera is described. In conclusion, nuclear-electronics applications are discussed. (auth)

33235 ANALYSER FOR FAST SINGLE EVENTS. J. W. Sedlmeyer, R. B. Patten, and L. Fussell, Jr. (Edgerton, Germeshausen and Grier, Inc., Las Vegas, Nev.). p.145-53 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In English)

An electronic analyzer has been designed and constructed for use with single non-recurring transient signals. The signal during passage along a coaxial line, is sampled instantaneously at a number of tap-off points by means of a single short-duration gate pulse. Multipoint time-dissection is accomplished using a gate-duration and a time-interval between samples, which are independently adjustable from about 4 ns. The time-intervals may be programmed in non-linear array, and jitter is less than 0.5 ns. The speed of response is at present limited by diode characteristics. Each sampled voltage is stretched in a circuit which retains the voltage amplitude. A time-stretch by a factor of 10^8 has been realized, with good stability. These data points may be commutated and transmitted over open-wire to low-frequency recording systems; they may be converted to digital form for rapid data-processing, using conventional equipment; and/or they may be presented visually. The analyzer is advantageous, compared with high-speed oscilloscopy, when large numbers of single-transients require individual analysis; such requirements exist for investigations into fluctuations in the response of systems, or for production-testing of components. The analyzer is advantageous when the data analysis must be accomplished quickly after the signal event occurs; it is not necessary to develop films or to read them. The analyzer is also advantageous when the analysis-computation center is located remotely from the event. Applications of this technique in the nuclear field are many. Fluctuation studies of reactors and subcritical assemblies may be carried out rapidly by pulsed neutron techniques. The build-up and decay characteristics of detectors may be determined, together with analysis of statistics and fluctuations. The pulse shape of the radiation wave from nuclear accelerators may be measured. Neutron spectrometry using the time-of-flight method may be facilitated. Isomeric studies involving half lives in the range 10 to 1000 ns, together with scattering investigations, may be carried out quickly and precisely. (auth)

33236 FAST COUNTING CIRCUITS FOR PULSED ACCELERATORS. I. Hayashi and N. Yoshimura (Tokyo Univ.). p.157-65 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In English)

A group of electronic circuits, which are able to analyze the nanosecond pulses (as fast as 10 ns) of the scintillation counter used in the synchrocyclotron experiments, has been developed. The group consists of the amplifiers, discriminators, coincidence circuits, scalers, linear gates, and pulse stretchers. Mesa transistors are used in the circuits extensively and some of the circuits also make use of the Esaki diodes. For the phase inversion and the current multiplication, the coaxial cable transformers with the ferrite core are employed. The rise time of this transformer is within a few nanoseconds, and can transform pulses as wide as 100 ns. The amplifiers are constructed with several transistors (emitter input type), which are connected in series with the pulse transformers. The rise time of the amplifier is found to be about 3 ns and a gain of 10 to 20 has been obtained. The output of the pulse stretcher is 1 ~ 2 μs, enabling the pulses to be analyzed by the ordinary multichannel pulse-height analyzer. Not only does the linear gate select the useful pulses by the coincidence input, but it is also able to control the speed of the pulses to be fed to the pulse-height analyzer. Two kinds of coincidence circuits, having resolving times of 30 ns and a few nanoseconds respectively, have been constructed with transistors (emitter input type). The accessory circuits were constructed, i.e. the current dividing circuits, variable attenuators, variable delays, phase inverters etc.; all of them have the same input and output impedance (125 Ω). Scattering experiments have been done, using these circuits. The output pulse current from the photomultiplier 6810 A, which is about 20 ns wide, has been analyzed. Resolution of the analyzed spectrum is nearly equal to that obtained by standard circuits, even at a high counting rate. (auth)

33237 THE DEVELOPMENT AND USE OF A FAST, STABLE DISCRIMINATOR FOR TENS OF MILLIVOLTS. L. Binard and E. Gourski (Centre d'Études de l'Énergie Nucléaire, Mol, Belg.). p.167-77 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In French)

Tube and transistor circuits have been developed with a view to simplifying and lightening nuclear measuring equipment. They are based on the standard method of positive feedback cut-off by means of the variable impedance of a diode. They have good stability, are sensitive to less than 50 mv for pulses of a few nanoseconds duration, and can withstand considerable overloads. With these circuits it is possible to build complicated measuring equipment of small dimensions (coincidence, anti-coincidence, etc.) using, with pratically no amplification, the signals given by the detectors. (auth)

33238 THE USE OF TUNNEL DIODES IN IMPULSION ELECTRONICS. J. Lacour (Centre d'Études Nucléaires, Grenoble, France). p.179-93 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In French)

The performance limits which can be expected with basic pulse systems using tunnel diodes are given. The response of a tunnel diode to a current step and to a square-wave current was studied. As an illustration, some actual systems and their performance are described. (auth)

33239 A FAST PULSE MEMORY USING A DELAY LINE. R. F. Rumphorst, C. Daum, and L. A. Ch. Koerts (Institut voor Kernphysisch Onderzoek, Amsterdam). p.195-204 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In English)

Severe limitations are set for the counting rates of detecting and analyzing equipment if incident particles arrive in short bursts. A fast memory which may, during one burst, store information which can be processed in the off-period of the accelerator would facilitate many experiments. Such a fast memory has been designed and is operating. It will store pulses from NaI-scintillation counters during 420 μs in a delay line of 60 μs length in a re-entrant fashion. Up to 20 pulses can be accepted from one burst. The arrival of the machine burst opens the entrance to the memory during a time-interval variable from 20 to 60 μs. The analyzing equipment is sampling the memory content continuously. Pulses which enter the analyzing equipment are destroyed in the memory. The memory is cleaned of

remaining pulses 420 μs after the beginning of the burst and is ready to accept new information. The gain of the ring-storage system is 1 ± 0.0005 during 8 h or more. (auth)

33240 A FAST TIME-AMPLITUDE CONVERTER FOR LOW-ENERGY PHYSICS MEASUREMENTS. M. Rogérieux and P. Vergez (Centre d'Études Nucléaires, Saclay, France). p.205-11 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In French)

This converter permits the measurement of neutron times of flight up to 150 ns. The saw-tooth generator employs a 6BN6 tube fed at low voltage. There are two main points to be noted. The first relates to the tube itself: the influence of the inter-electrode capacitances increases with the speed of the signals, so that it was necessary to provide efficient neutrodyning of the No. 3 grid anode capacitance, which disturbed the conversion. The other point is that the exactness of the time definition is limited owing to the amplitude spectrum of the signals from the photomultiplier which makes it difficult to determine the instant that corresponds to a pulse. To reduce this difficulty, the authors took a selection of measurements. The performance of the equipment was checked under simulated normal working conditions: the two instants are defined by two distinct detection channels, each having a photomultiplier and a scintillator. The half-height width of a peak corresponding to a fixed delay gives the time definition; values were obtained from 0.8 to 1.3 ns for the half-height width of the peak, depending on the setting, and the drift for 15 hours of operation remained less than 0.3% of the range. The linearity of the response curve as measured by accident coincidence is better than ±0.3% between 5 and 95% of the measured area. (auth)

33241 A POLARIZATION-SENSITIVE COMPTON SPECTROMETER OF HIGH EFFICIENCY. U. Cappelier, R. Sturm, and R. Thielmann (Universität, Margurg, Ger.). p.215-21 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In English)

Measurements of the polarization-direction correlations in complex γ-ray spectra require the application of energy-selective Compton spectrometers of high efficiency. Compton spectrometers constructed in the usual way are most unfavorable for this purpose because high efficiency can only be obtained by loss of energy selectivity and vice-versa. The use of electronic summing makes it possible to build a Compton spectrometer whose energy selection depends only on the properties of γ-ray detectors used, not on the geometry of the arrangement. Certain difficulties concerning energy determination, caused by Compton scattering in the second detection crystal, can be avoided by a special method of electro-optical discrimination. This method also permits the elimination of the influence of multiple scattering in the scattering-crystal which would decrease the polarization sensitivity, especially for high γ-ray energies. A Compton spectrometer, working according to this principle, is described. Results are given concerning the energy-resolution and polarization sensitivity. (auth)

33242 IMPROVED METHOD FOR LIFETIME MEASUREMENTS. P. Weinzierl and W. Bartl (Österreichische Studiengesellschaft für Atomenergie, Seibersdorf, Austria). p.223-8 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In English)

The measurement of the lifetime of excited states of nuclei is mostly based on the measurement of the delay of a γ ray (II) with respect to another γ ray (I) or a β particle. Organic scintillators allow the best time resolution for the measurement of this decay time, but for complicated decay schemes the identification of γ energy is important and best achieved by NaI(Tl) scintillators. To combine the merits of both detectors the γ ray (II) is at first scattered in an organic crystal (stilbene) and the scattered quantum is detected in a NaI(Tl) crystal. In order to allow large acceptance angles between the two scintillators, the measurement of the γ energy is achieved after adding the pulse heights of both scintillation pulses. To allow a reliable function of the adding unit the pulses from the organic crystal pass first through a gate circuit which is triggered by coincidence between the two scintillators. The pulse spectrum from the adding unit is fed to a single-channel analyzer for energy selection. γ ray (I) is detected in another organic crystal. Fast pulses from both organic scintillators go to a time-to-pulse-height converter and multichannel analyzer. This analyzer is gated by a slow coincidence between the pulse-height discriminators. (auth)

33243 USE OF SEMICONDUCTORS IN LIEU OF EMULSIONS IN NUCLEAR SPECTROSCOPY. O. M. Bilaniuk and B. B. Marsh (Univ. of Rochester, N. Y.). p.231-9 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In English)

Twenty surface-barrier counters obtained by evaporating gold on to n-type germanium, or junction counters produced by diffusing phosphorus into p-type silicon, are placed in the image plane of a high-resolution magnetic spectrometer in place of a nuclear emulsion plate. To avoid the use of separate amplifiers and registers for each crystal, the outputs of individual counters are connected into a lumped delay line, replacing alternate capacitors of the line. When an ionizing particle strikes a counter, the resultant pulse travels toward both ends of the delay line. Each of the 20 stages of the line consists of two 35-μH inductances and two 60-μμF capacitors of which one is the counter itself and its leads. These components provide for a delay of $t = 2(LC)^{\frac{1}{2}} = 90$ ns per stage. Thus the time difference between pulses arriving at the ends of the delay line will differ by 180 ns for two adjacent detectors. The two ends of the delay line are connected into a "start" amplifier and a "stop" amplifier respectively, followed by identical shaping and trigger circuits. Their outputs operate a 6BN6 time-to-pulse-height converter. A fixed delay of 2.5 μs is included in the stop amplifier, which ensures that the stop pulse always arrives at the time-pulse-height converter after the start pulse. The amplitude of the pulse coming out of the 6BN6 converter is proportional to the time difference between the start and stop pulses. Thus, signals originating in various counters of the mosaic are decoded by pulse height. The resulting groups of counts are displayed on the screen of a 400-channel pulse-height analyser, printed out, and graphed by an X-Y recorder. The groups are entirely resolved so that the decoding is complete. The decoding circuit can accept a pulse every 8μs so that the limitation for the counting rate does not stem from this unit but from the 400-channel analyser. The decoding unit has been found to perform satisfactorily with the magnetic field present and with the cyclotron in full operation. Complete circuitry of the decoding scheme is presented and samples of nuclear data collected with the unit are shown. (auth)

33244 ALPHA SPECTROSCOPY APPARATUS USING A SEMICONDUCTOR DETECTOR. A. Blanc and G. Roux (Centre d'Études Nucléaires, Saclay, France). p.241-7 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In French)

Semiconductor detectors permit precise measurement of

α particle energy. The experimental equipment described includes: a detection head surrounding a primary vacuum and arranged specially for α spectroscopy, a low-background preamplifier with a response proportional to the charge collected by the detector, a conventional amplifier, and a multi-channel selector. The electronic background is reduced by selecting the most appropriate entrance and pulse-shaping circuits. The source and detector are placed in such a way as to ensure minimum dispersion of the energy of the incident α particles. Resolutions of approximately 30 kev have been obtained for the α particles of U^{233} with a recent prototype detector. (auth)

33245 A HEAVY PARTICLE BEAM ANALYSER WITH A MOSAIC OF JUNCTION DETECTORS. F. Valentin (Université Bordeaux). p.249-61 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In French)

The problem is to make appear on a cathode oscilloscope screen a matrix of luminous points whose brilliance will depend upon the number of nuclear particles between 0.01 to 1000 particles per second striking a planomosaic of semi-conductor diodes. The initial matrix studied consists of 100 elements (10 rows of 10 columns each) scanned 100 times per second, which gives a commutation time of 100 μs. The equipment comprises three parts: the semiconductor detectors with their amplifiers, the commutation matrix, the CR tube, and its scanning system. Each semiconductor diode is followed by a transistorized pulse-amplifier which brings the signal to a level compatible with easy commutation (100 mV to 1v). These pulses are stored in a low-capacity integration capacitor. A high-impedance commutation matrix is used (in view of the weakness of the charges involved); it has eight diodes per commutation point and practically discharges the capacitor for each sweep. The Wehnelt cylinder of the CRT is connected to an amplifier at the commutator output. Scanning is stepped in X and Y. The fluorescent screen is of type R and its afterglow effect provides the required time constant, which is approximately a second. (auth)

33246 FAST, REMOTE READ-OFF FOR BINARY SCALE COUNTERS. J. C. Brun, P. Antoine, G. Corbé, J. G. Schiller, and C. Victor (Université Paris, Orsay, France). p.267-73 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In French)

A device is described for the rapid, remote transfer of the information contained in a 2^{20} scaler which includes transformation of the parallel number to a series number of one microsecond duration and application for nondestructive reading of a counter group connected to a scintillation detector with 30 simultaneous channels. (auth)

33247 THE TRANSMISSION OF A PULSE SPECTRUM FROM A ROCKET. G. Ducros and J. Goupil (Centre d'Études Nucléaires, Saclay, France). p.275-85 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In French)

A transistorized device is described for transmitting from one of the ONERA's four-stage ANTARES rockets the pulse spectrum obtained from a γ scintillation detector. The transmitting unit itself is not described, but it is a 100-MHz transmitter, equipped with five sub-carriers with a pass-band of 400 Hz. The width of the pulses at the input of the device is about 5 μs and their mean frequency is variable between 0 and 20000 cps. Their distribution with respect to time is Gaussian. Preliminary sampling is therefore desirable, followed by expansion of the pulse width to 10 ms. The different parts of the equipment are described: amplitude-time and time-amplitude converters, linear gate, distributors operating at ±2% from 25°C to 65°C. The ancillary circuits are also dealt with: amplifiers, scalers, and stabilized power units (low voltage and extra high voltage for a photomultiplier). (auth)

33248 MULTI-CHANNEL SYSTEMS USED FOR HIGH-ENERGY PARTICLE RESEARCH ON THE JINR SYNCHRO-CYCLOTRON. A. N. Sinaev. p.287-97 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In Russian)

The working conditions of a synchro-cyclotron present a number of special requirements concerning the electronic equipment used for high-energy particle research. The most important features are the pulsating operation of the synchro-cyclotron and the necessity of isolating the processes under investigation from many others and from the external radiation background. Multi-channel systems are widely used with a synchro-cyclotron for work on angular distribution, energy spectra, and the lifetimes of various nuclear particles, as well as for research on other nuclear processes. The paper presents original systems developed in the Nuclear Research Laboratory. (auth)

33249 THE DETECTION OF THERMAL NEUTRONS BY SCINTILLATION WITH A RESOLVING TIME OF 10^{-9}s. R. Bomal and L. Koch (Centre d'Études Nucléaires, Saclay, France). p.299-307 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In French)

A thermal neutron detector of short resolving time, consisting of a gaseous scintillator and a target of fissile material was studied. The detector has the following characteristics: luminous intensity proportional to the energy imparted to the gas by the fission products; resolving time 2.3×10^{-9}s; almost complete insensitivity to γ rays. When the detector is used in conjunction with a photomultiplier, the information is collected in the form of electric pulses of high amplitude (from several volts to several tens of volts) and can be transmitted over some distance and recorded without difficulty. The apparatus described can be used for measuring neutron flux in reactors (power control) and for studying reactor kinetics by the oscillation method. (auth)

33250 AN 8-CHANNEL HODOSCOPIC CIRCUIT USING SCINTILLATION DETECTORS. Yu. D. Bayukov, Yu. M. Zaitsev, et al. p.309-21 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In Russian)

The hodoscopic arrangement described was developed to obtain information on the $\pi\pi$-interaction by studying the reaction involved in the formation of a π-meson by a π-meson with hydrogen ($\pi^- + P \rightarrow \pi^- + \pi^+ + \eta$) (I). This required the construction of a multi-channel system capable of enclosing a large solid angle. Analysis of the recording efficiency in cases involving reaction (1) showed that sub-division of the system into 8 channels gave the optimal conditions with regard to the efficiency and complexity of the system. Reaction (1) is accompanied by background processes with elastic scattering of π-mesons and charge-exchange scattering owing to the relatively large cross section. The layout of the block diagram and the parameters of the equipment were determined by the necessity of ensuring that these processes and the background of random coincidences were not recorded. The electronic system was designed to pick out the cases involving reaction (I), which are then photographically recorded in a spark chamber working in conjunction with the system. (auth)

33251 A NANOSECOND PULSED ACCELERATOR FACILITY. E. F. Shrader, R. I. Zimmerman, and L. Cranberg (Case Inst. of Tech., Cleveland). p.325-34 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In English)

The operation and performance of a 3-Mev pulsed electrostatic generator producing 1-ns (10^{-9} s) pulses are described. The system employs terminal pulsing and post-acceleration time-compression to achieve short pulses and high average current. The specifications for this system were based on the following considerations. A 10-μa average beam current represents a reasonable limit based on the ability of a target to dissipate beam power, the 1-ns pulse-length was consistent with other factors such as detector response, energy homogeneity, etc. which determine over-all time resolution, and a repetition rate of 1 MHz/s gives a duty factor consistent with the current capabilities of existing accelerator ion sources. The system consists of a terminal pulsing component which produces pulses of 10 ns in duration by sweeping a beam over an aperture located at the entrance to an accelerator tube. An average output of a current of 10 μa requires a source capable of producing 1 ma of atomic ions. After acceleration this pulse is compressed to 1 ns by the scheme suggested by Mobley. This involves sweeping the beam with proper synchronization across the aperture of a 90° doubly-focusing deflection magnet so that the early portion of the pulse travels through a longer trajectory than the later portions, thus achieving time compression when the beam is brought to a focus on a suitable target. The radius of beam curvature in the compression magnet is 30 in. and the over-all beam divergence at the target is 5°. The choice of these parameters and the effect of the deflection scheme in the beam-energy homogeneity will be discussed. Using existing nanosecond detector techniques, this system has produced over-all system resolutions of 1 ns full-width at half-maximum for both gamma rays and neutrons. It is not yet known what component or components of the system determine the limits on the time resolution of the system. As a facility for investigating neutron inelastic scattering and neutron-producing target reactions it represents at least two orders of magnitude higher performance than most existing pulsed facilities. The demands placed by this system on determining and recording time-of-flight information are discussed. (auth)

33252 EQUIPMENT FOR FAST NEUTRON TIME-OF-FLIGHT EXPERIMENTS. A. T. G. Ferguson, P. R. Orman, and J. H. Montague (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.335-41 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In English)

A 3-Mev-pulsed Van de Graaff has been built. It is designed to give pulses of 1 ns duration at a repetition frequency of 1 MHz and a current in the pulse of 10 ma. This machine is to be used for fast neutron spectroscopy and a system of electronics for this purpose has been devised. The system is intended to record time intervals up to 1 μs with a resolution of ~3 ns. The timing cycle is started by a start pulse from the neutron detector. The stop pulse is derived from the beam, and delayed by 1 μs. The start and stop pulses are fed to a time expander which expands the time interval between the pulses by a factor of ~250. The expanded time interval is then recorded in digital form on 16-track magnetic tape. (auth)

33253 AN ISOFIELD-CHART TRACER IN AN ELECTROMAGNETIC PARTICLE DEFLECTOR—A TRANSISTORIZED BEAM MONITOR. E. Consigny, R. Dumaye, and P. Lefrère (Centre d'Études Nucléaires, Saclay, France). p.357-71 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In French)

An arrangement is described for automatically tracing isofield charts in an electromagnetic particle deflector. A Hall-effect probe attached to a pointer scans the magnetic field above an aluminum plate covered with metallized paper. The voltage delivered by the probe is converted into pulses by a comparator system. These pulses are compared with a train of calibrated pulses (calibrated in gauss) which is triggered by appropriate synchronization. At the instant of coincidence of the measured pulse with a predetermined pulse a direct voltage is applied to the pointer which then marks a dot on the metallized paper. A magnetometer with several paths is then discussed. As far as concerns the comparators, the principle is similar to that described above. The pulse produced by the comparison system stops a train of pulses (spacing calibrated in gauss) which has been triggered at the same time as the comparator. The pulses are counted by a binary-type scaler, with direct plotting of the field. By means of a ten-way electronic switch the measuring device can be switched to ten probes in succession. Finally, the construction by a transistorized beam monitor is described with the following characteristics: width of measured pulses less than 10^{-8} s, maximum pulse repetition rate 10^7 per second. Apart from counting the pulses the distribution of particle flux with respect to time for each burst of particles from the synchrotron during a given period of time is recorded. (auth)

33254 BACKGROUND REDUCTION IN NUCLEAR REACTION AND SCATTERING EXPERIMENTS BY MEANS OF A CYCLOTRON-D VOLTAGE REGULATOR. F. H. Schmidt, H. Fauska, and J. W. Orth (Univ. of Washington, Seattle). p.381-6 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In English)

In a nuclear reaction or scattering experiment the background due to pile-up pulses occurring within the resolving time of the detector limits the maximum permissible counting rate. On the other hand, the duty cycle of the accelerator often presents a second limitation. The feasibility of a given experiment may rest upon having a sufficient counting rate, and hence upon obtaining a high duty cycle from the accelerator. When a narrow band of energies is selected from the external beam of a cyclotron by means of magnetic separation, the resultant beam is severely modulated by small variations in D-voltage. In fact, only $\frac{1}{10}$ to $\frac{1}{3}$ of the RF beam pulses were present in the beam of the University of Washington 60-in. cyclotron. To improve the duty cycle a regulator has been constructed which maintains the D-voltage constant to ±0.1%. With the regulator in operation the beam pulses are modulated in intensity by 50% or less. The device is decisive especially in low-yield coincidence experiments where it reduces the background counting rates, for the same total rates, by a factor of five to ten. The regulator proper utilizes an ML-6696 power triode in series with a 100-kW oscillator power supply. Grid control of the series tube is achieved by means of a unique dual amplifier and mixer circuit. One amplifier is a direct-coupled unit driven by a rectified signal derived from the D-voltage amplitude. The other is an AC unit driven by a signal from the plate power-supply voltage. The role of the latter is to anticipate changes in D-voltage which would otherwise occur at a later time. This time delay in D-voltage response is due

to the high "Q" of the D system. Broadly speaking, the AC section removes power-supply ripple, whereas the DC portion corrects for changes within the cyclotron. The regulator can be pulsed externally so as to produce a cyclotron beam of any desired time-duration down to about 1 ms. The regulator is now used for all nuclear reaction and scattering studies, and several experiments are in progress which were hitherto out of reach. (auth)

33255 APPARATUS FOR DETECTION AND MEASUREMENT OF RADIOACTIVE CONTAMINATION. P. Desneiges (Centre d'Études Nucléaires, Saclay, France). p.389-402 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In French)

The various types of apparatus which have been made in France for the purpose of detecting contamination are reviewed, and the limitations of the methods used are examined. In addition to apparatus in common use, such as portable detectors, detectors for hand contamination, etc., mention is made of newer apparatus, specially designed for detecting certain aerosols or direct contamination of the human body. (auth)

33256 INSTRUMENTS FOR PLUTONIUM MONITORING. N. T. Clarke and N. Pearce (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). p.403-27 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In English)

The Pu^{239}-in-air filter paper monitor (NLS. 280) has been developed for emergency application when levels of 50 MPC or more may be encountered. A measurement of Pu^{239} on a filter paper is required with the minimum of delay and so must be made with radon and thoron decay products present. A scintillation counter is arranged so that two energy channels may be counted simultaneously. By examining a large number of samples taken with different radon and thoron backgrounds, a correcting ratio may be obtained which gives the contribution in the Pu^{239} channel arising from degraded pulses from radon and thoron. The plutonium-in-air alarm monitor (NLS. 223) gives a rapid warning of the release of plutonium into the atmosphere by continuously sampling air for plutonium alpha activity. The plutonium particles are impacted on to a zinc-sulfide coated film which is measured continuously with an alpha scintillation counter. Sampling is carried out for pre-set periods (e.g., 10 min) and the integral count is recorded at the end of each period. When a pre-set integrated count is exceeded an alarm is given. A Surface Contamination Monitor for Pu^{239} has been developed employing a probe which detects the x-ray emission which occurs in about 4% of the alpha disintegrations. The monitor circuit is limited in response to 10 to 25-kev photons, thus reducing sensitivity to background radiation. The equipment will measure down to 3 μc of P^{239}/m^3 in backgrounds of up to 10 $\mu r/h$. (auth)

33257 PERSONAL-RADIATION MONITOR. C. J. Borkowski and R. H. Dilworth (Oak Ridge National Lab., Tenn.). p.429-40 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In English)

A personal-radiation monitor instrument has been developed that weighs 3½ oz and is the size of an ordinary fountain pen. Worn in the pocket of the user, the device provides immediate audible and visual indication of gamma dose-rate of from background to 200 r/h. The flashing rate of a neon lamp and the pitch of an audible warning tone increase in proportion to dose rate. In its normal mode of use, the alarm-tone pitch reaches a limit of 2800 Hz at about 2 r/h. If required, the instrument can be inverted and a 100 times decrease in sensitivity is effected by a mercury-attitude switch. In this inverted mode the limit of proportional indication is about 200 r/h. In either normal or inverted modes the maximum indications do not block in overloading-radiation fields short of that which would damage the components. To insure continuous protection, there is no on-off switch. Operation for one month is obtained from a 4-v mercury battery. The instrument utilizes a miniature halogen-filled Geiger counter as the radiation detector. This counter is operated in an unorthodox, externally-quenched mode in conjunction with a constant-efficiency power supply to obtain about 100 times greater current output than that of conventional self-quenched counters in relatively low dose-rates. The attitude-switch range-change is accomplished by providing conventional self-quenching for the less sensitive inverted mode. The interaction of these quenching modes with the special power supply provides the nonblocking characteristic which is applicable to other safety and monitoring applications employing Geiger counter detectors. Generation of 500 v for the Geiger counter is accomplished by a transistor-blocking oscillator, transformer, and semiconductor diode-voltage quadrupler. Feedback through a second transistor-emitter follower increases the rate of the oscillator in proportion to Geiger counter current, and a third transistor amplifies this tone into a hearing-aid earphone with resonant air column. The electronic assembly is encapsulated in epoxy resin for protection and housed in a tubular stainless-steel case fitted with a pocket clip. (auth)

33258 A SENSITIVE CURRENT INTEGRATOR. V. Ya. Goloviya, I. I. Zalyubovskii, and B. A. Shilyaev. p.441-5 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In Russian)

In various physics applications the need may arise to measure small beams of charged particles. For this purpose equipment was developed based on the discharge of a capacitor by the current that is being measured; the capacitor is charged by a multi-vibrator forming part of the circuit. The sensitive element of the circuit is a 6J1J-type tube operated as an electrometer. With a sensitivity stability of 1% a current of 10^{-13} a can be measured with high accuracy. If the operating range of the measuring tube is especially selected, the leakage current can be compensated by thermal electrons. The leakage current may then be reduced to 10^{-16} or 10^{-17} which permits measurement of currents of 10^{-14} to 10^{-15} a with an accuracy of 1%. (auth)

33259 APPARATUS FOR RECORDING IODINE-131 ACTIVITY IN THE ATMOSPHERE OF LABORATORIES PRODUCING ISOTOPES. A. Blanc and J. Lequais (Centre d'Études Nucléaires, Saclay, France). p.447-54 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In French)

In laboratories preparing I^{131}, where it is extracted by distillation from telluric acid, there is a risk of personnel contamination should a leak occur in the apparatus. The device presented records the activity in the air and gives an alarm when this activity reaches a predetermined value or undergoes an abnormally rapid change. Air is aspirated (at 20 m^3/h) across a specially-shaped tube of activated charcoal surrounding a crystal scintillator. The iodine thus permanently collected accumulates at a short distance (a few millimeters) from the detector. The γ activity of the iodine is counted selectively in an energy band centralized on 0.364 Mev, but shielding with lead is, however, essential owing to the high γ background, variable in

intensity and energy, found in these laboratories. These precautions reduce the γ background by a factor of over 1000. The apparatus integrates the I^{131} dose with a time constant of 8 days. Under the conditions of use, appreciable zero displacement is not observed and permanent leaks are insignificant. A small accidental leak producing in the air 1 MPC is detected in approximately ½ hour, and the time necessary for the detection of such leaks is inversely proportional to the concentration. In addition, a special circuit gives an alarm in case of any rapid increase of activity. (auth)

33260 A RADIATION-CONTROL SYSTEM THROUGH NORMAL TELEPHONE LINES. B. J. Kovač, S. D. Mužđeka, and M. V. Sobajić (Boris Kidric Nuclear Inst., Vinča, Yugoslavia). p.455-8 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In English)

A transistorized logarithmic rate meter useful for radiation control or alarm system is described. The instrument, connected to a normal phone apparatus, gives information on the radiation level in a desired area, as an answer to a phone call without the presence of the laboratory personnel. (auth)

33261 A RADIOISOTOPE-LOCATOR USING A COINCIDENCE CIRCUIT. S. Kobayashi, S. Arai, K. Saito, and J. Tarao (Tokyo Shibaura Electric Co., Ltd., Kawasaki, Japan). p.463-75 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In English)

The presence of radioisotopes is usually detected with survey meters. While a survey meter can show that a radioisotope exists in the neighborhood, it cannot tell its exact location or direction. For this reason, the "U-scope" was invented by Professor Takahashi. It can determine the direction of gamma-ray sources and their relative intensities. A NaI scintillation detector with a lead collimator is rotated and its output pulses are displayed on a Braun radar-tube. Similar equipment using two scintillation detectors was constructed. One scintillation detector rotates around another one and the coincident output-pulses of both are counted. The counting rate of the rate meter is recorded on a polar co-ordinate pen-recorder. (A Braun tube display is of course possible.) This equipment makes a heavy lead collimator unnecessary and the background counting-rate is extremely small. On the other hand, the absolute value of the counting-rate is somewhat small, but this defect is cancelled by the small background counting-rate and a satisfactory result is obtained. As scintillators we used a 1.5-in diam. × 1-in NaI-scintillator and a 50-mm diam. × 75-mm plastic scintillator. If a 1-mc Cs^{137} gamma-source is 5 m away, the counting rate is about 65 cpm when the rotating scintillation detector is on the direction of the gamma-source and less than 1 cpm when the rotating scintillation detector is on the reverse side of the gamma source. Analyzing the pattern on the recorder obtained at several different locations, a gamma-source can be easily located. It can be very useful, as in the case of a U-scope, in uranium mine surveys, and in the event of an accident at a radioisotope laboratory, etc. (auth)

33262 A SINGLE-TRANSISTOR GM MONITOR WITH A STABILIZED GM SUPPLY. J. Keller (Badan Jadrowych Inst., Warsaw). p.497-502 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In English)

The pulses from the GM counter are amplified by a transistor—the single active element of the monitor—and after transformation and rectification are used as the DC supply for the GM counter. The rectifier, a voltage doubler, contains a cold cathode tube, which both rectifies and stabilizes the rectified DC voltage. This DC voltage is defined by the "on" and "off" voltage of the corona discharge of the cold cathode tube. (auth)

33263 GAS-FLOW DETECTOR FOR URANIUM CONTAMINATION ON FINNED-CAN SURFACE OF A REACTOR FUEL. H. Miwa, T. Shiojiri, and Y. Maeda (Kobe Kogyo Corp., Hyogo, Japan). p.503-12 of "Nuclear Electronics. Vol. III." Vienna, International Atomic Energy Agency, 1962. (In English)

This gas-flow detector is a gridded proportional-counter especially designed for detecting uranium contamination on the finned-can surface of a reactor fuel. A conventional proportional-counter constructed only by a cathode and collector can hardly detect alpha particles emitted from uranium which is contaminated on rugged surfaces such as those of the fins of a reactor-fuel can because of the lack of uniformity of the electric field near the surface. This is the reason why we have constructed the gridded proportional-counter. This counter comprises the fuel, a grid, collectors and a cathode which are cylindrical in construction and arranged coaxially. The fuel is placed in the center of the grid and negative voltage is applied. The space between the fuel and the grid serves as an ion-collecting space. The grid is made of fine parallel tungsten wires which are constructed cylindrically around the fuel and connected to ground potential. The collectors are 16 fine tungsten wires constructed similarly to the grid, but each wire is electrically insulated from the others. Through 50-kΩ resistors all collectors are connected together and to positive high voltage via a feeding resistor. The space between the grid, the collectors and the cathode serves as a gas-multiplication space just like a conventional proportional-counter. Each 50-kΩ resistor separates the stray capacity of the connected collector from the others. The detector output is coupled with a low input-impedance-current amplifier. The low input-impedance also lessens the bad influence of the stray capacity of the input circuitry. These result in a good S/N ratio and allow the sensitive detection of alpha particles. Before measurement, the counter is first evacuated by a rotary pump and then PR gas (Ar: 90%, methane: 10%) is admitted. By the use of this new equipment alpha particles emitted from 1×10^{-6} g natural-uranium contamination of the finned-can surface of a Calder Hall-type reactor-fuel were detected, and all JRR-3 fuels are to be inspected by this counter. (auth)

33264 TELEMEASURING APPARATUS. (to AEI-John Thompson Nuclear Energy Co., Ltd.). French Patent 1,248,934. Nov. 14, 1960.

For measuring the temperature at inaccessible locations, e.g., the temperature of fuel elements positioned one above the other in a vertical reactor channel, it is difficult to introduce conducting wires into the channel in such a way that the fuel elements can easily be discharged. Thus, this telemeasuring apparatus comprises an electric resonant circuit, the resonance frequency of which is controlled by the quantity to be measured, and a measuring circuit connected by inductive coupling with the resonant circuit, this measuring circuit comprising a measuring instrument and an alternating current generator. Preferably the capacitance of the resonant circuit is changed dependent on the temperature to be measured. With this measuring method a quantity representing the total of the temperatures of a series of fuel elements may be measured. In this case each fuel element has a resonant circuit connected by inductive

coupling with the circuits of the adjacent fuel elements, so that these circuits form a composed resonant circuit, the resonance frequency of which is determined. (NPO)

33265 DEVICE FOR MEASURING THE DISPLACEMENT OF NON-ACCESSIBLE OBJECTS. (to Commissariat a l'Énergie Atomique). French Patent 1,256,113. Feb. 6, 1961.

For measuring the displacement of nonaccessible objects, especially reactor control rods, a device is provided comprising three primary windings and three secondary windings coaxially mounted in the same cylinder. Each of the primary windings belongs to a given secondary winding, while these three groups of two windings are placed one upon the other with an angular shift of 120° between adjacent groups. The central cylindrical space between the cores of the windings constitutes an air-gap in which a magnetic rod moves axially and which is threaded or provided with regularly distributed grooves and which is fixed to the object of which the displacement is to be measured. The primary windings are fed with an alternating current, while the output of the secondary windings after amplifying is fed over further electric transducing means to the three windings of a magnesyn, the position of the rotor of which is proportional to the displacement to be measured. (NPO)

33266 POSITION INDICATING DEVICE. (to United Kingdom Atomic Energy Authority). French Patent 1,259,242. Mar. 13, 1961.

A device for indicating that a selected relative position is occupied by two relatively movable members has two magnet systems, one mounted on each member. One of the magnet systems comprises a single magnet with its poles oriented along the direction of relative movement of the members and the other system comprises a pivotally mounted indication member biased towards an undeflected position. A pair of magnets is spaced apart on the indication member, one to either side of the pivot. Poles of the same sign of the pair are spanned by the single magnet when the members occupy the selected position so that the indication operating member is rotated to a deflected position. (NPO)

33267 PROCESS FOR NEUTRON FLUX MAPPING IN A NUCLEAR REACTOR CORE. (to United Kingdom Atomic Energy Authority). French Patent 1,259,687. Mar. 20, 1961.

A process for neutron flux mapping in a reactor core consists in passing a fluid through a conduit in the core and following the path along which the neutron flux is to be measured. The fluid is allowed to remain in this conduit for a period to induce radioactivity. Thereafter the fluid is removed while simultaneously observing its activity so as to obtain the distribution of the neutron flux along the conduit passing through the core. (NPO)

33268 DEVICE FOR MEASURING THE ENERGY DEVELOPED IN A NUCLEAR REACTOR OR IN ELECTRIC DISCHARGE EQUIPMENTS. (to Associated Electrical Industries Ltd.). French Patent 1,259,728. Mar. 20, 1961.

When nuclear particles pass through a dielectric medium with a speed higher than the velocity of light in this medium, a radiation arises known as Cherenkov radiation. The intensity of Cherenkov radiation arising in a reactor is measured in order to determine the energy developed in the reactor. The dielectric medium is enclosed by a biological shielding through which a light guide passes for the transmission of the light component of the Cherenkov radiation to a point outside the biological shielding. This light guide follows a zig-zag path preventing the escape of dangerous radiation, e.g. gamma radiation. Outside the biological shielding a photoelectric cell is placed for measuring the intensity of Cherenkov radiation transmitted by the light guide. (NPO)

33269 POSITION INDICATING DEVICE, ESPECIALLY FOR THE CONTROL RODS OF A NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,261,620. Apr. 4, 1961.

In reactors it is often necessary to control in synchronism the movement of a number of control rods. If there is a relatively great number of position indicators, it is difficult for the operator to check a deviation. Thus, means are provided for scanning step by step in a cyclic sequence the positions of a number of elements controlled in synchronism and for comparing these positions with a reference position so that the signal representing the difference of the two positions is determined. Warning means gives an indication when this latter signal reaches a given level. (NPO)

33270 EQUIPMENT FOR DETECTION OF RADIATION IN A FIELD. (to Associated Electrical Industries Ltd.). French Patent 1,261,628. Apr. 10, 1961.

The intensity of Cherenkov radiation arising in a transparent reactor coolant is measured in order to determine or to control the energy developed in the reactor. For performing this measurement a closed duct for the reactor coolant is provided in which flows the coolant coming from the reactor. The radioactivity of the coolant induced by the neutron flux in the core comes from the activity of nitrogen-16 which is a beta emitter with a decay period of 7.4 sec. The Cherenkov radiation arising in the coolant is measured by photoelectric cells near the two ends of the duct, so that one photoelectric cell measures the intensity in the coolant entering the conduit, the intensity of which comes from the activity of fission products in the coolant itself, while the other one measures the intensity in the coolant leaving the duct, which intensity only comes from fission products because the activity of the coolant already has disappeared to a great extent. The difference of the measuring signals is proportional to the energy developed in the reactor. (NPO)

33271 IMPROVEMENTS RELATING TO DEVICES FOR THE DETECTION OF FISSION PRODUCTS IN THE COOLANT OF A NUCLEAR REACTOR. (to Associated Electrical Industries Ltd.). French Patent 1,261,629. Apr. 10, 1961.

When nuclear particles pass through a dielectric medium with a velocity higher than the velocity of light in this medium, a radiation arises known as Cherenkov radiation. In a transparent dielectric reactor coolant, e.g., water, beta emitters are detected by the measurement of the induced Cherenkov radiation. Preferably a by-pass to the reactor cooling circuit comprises a variable speed pump, delay means for the coolant, and a radiation detector with a photoelectric cell. With the variable speed pump and the delay means, the time necessary to convey the fission products from the reactor to the detector is controlled so that the activity induced in the coolant itself has disappeared. Nearly all activity comes from nitrogen-16 which has a short decay period. (NPO)

33272 PROCESS AND DEVICE FOR THE LOCALIZATION OF LEAKAGE IN A HEAT EXCHANGER. (to Sulzer Freres Societe Anonyme). French Patent 1,269,168. July 3, 1961.

In a nuclear power installation a heat exchanger comprises tube banks placed in a casing through which the heating fluid flows. The heated fluid flows within the tubes. It is necessary to cut off immediately the tube bank in which a leak arises in order to prevent escape of the heated fluid into the heating fluid. A method for the localization of

a leakage in the heat exchanger, after having established that there are traces of the heated fluid in the heating fluid, is described. The method consists of adding a detecting material to the heated fluid. At least one sampling point is provided within the heat exchanger casing from which samples of the heating fluid are taken by a sampling line. The quantity of detecting fluid in these samples is determined. (NPO)

Materials Testing

33273 (ANL-6414) PROGRESS REPORT ON NON-DESTRUCTIVE TESTING BY ELECTROMAGNETIC METHODS. C. J. Renken (Argonne National Lab., Ill.). July 1962. Contract W-31-109-eng-38. 27p.

Activities in a program to improve electromagnetic and eddy current test methods and equipment are summarized. A description of a modified version of the multifrequency eddy current testing system is presented along with discussions of various specific uses. Other information is given concerning through-transmission testing systems using pulsed eddy current fields. Information is also included concerning the use of fields and masked aperture assemblies in test arrangements which permit the inspection of the specimen from one side only. Such an apparatus incorporates the convenience of conventional eddy current test equipment and good features of the through-transmission system. (J.R.D.)

33274 NON-DESTRUCTIVE INSPECTION OF NUCLEAR FUEL IN THE U. S. R. S. Paul. Nippon Genshiryoku Gakkaishi, 4: 549-54(Aug. 1962). (In Japanese)

GEOLOGY, MINERALOGY, AND METEOROLOGY

33275 (GCA-TR-62-1-G) CALCULATION OF THE DIFFUSION OF SMALL PARTICLES IN A NON-UNIFORM ATMOSPHERE. Milton M. Klein and Kwang Yu (Geophysics Corp. of America, Bedford, Mass.). June 1962. Contract DA-49-146-XZ-075. 39p. (DASA-1298)

The downward motion of small particles in an isothermal turbulence-free atmosphere was studied for the case of variable diffusion coefficient, utilizing two models. In the first of these, the diffusion coefficient has been taken as an exponential function of altitude while in the second, the variation has been assumed to be parabolic. In the exponential model an analytic solution for simultaneous diffusion in the vertical and horizontal directions has been obtained; while for the parabolic model, an analytic solution for vertical motion only has been obtained. The calculations, which have been restricted to the exponential case show the development of a profile of constant shape, all points of which move with the same velocity, independent of the mass of the particles. These results, which are derivable from our solution, are in agreement with the numerical work of Banister and Davis. It is also shown that the qualitative nature of the results is independent of the initial distribution. (auth)

33276 (HW-SA-2723) TRACER TECHNIQUES AND FIELD PROCEDURES USED IN THE CAPE CANAVERAL AND VANDENBERG AIR FORCE BASE DIFFUSION EXPERIMENTS. J. J. Fuquay, C. L. Simpson, and C. E. Elderkin (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [Aug. 29, 1962]. Contract [AT(45-1)-1350]. 24p.

The fluorescent atmospheric tracer technique and procedures used to apply the technique to diffusion studies at Cape Canaveral, Florida and Vandenberg Air Force Base, California are described. The tracer material used was ZnS. The fluorescent pigment was dispensed by an aerosol fog generator. Samplers consisted of membrane filters inserted in disposable polyethylene holders. The zinc sulfide collected on the filters was activated by alpha bombardment resulting in scintillations which were counted. Preliminary results of the studies are discussed. (M.C.G.)

33277 (RME-4539(Rev.)) RECONNAISSANCE FOR URANIUM IN THE COPIAPO AREA, PROVINCE OF ATACAMA, CHILE. William A. Bowes, Paul H. Knowles, Mario Serrano C., and Rudolfo Gruenwald (Division of Raw Materials, AEC and Chile. Instituto de Investigaciones Geológicas, Santiago). June 1962. 30p.

The Copiapó area, as broadly defined, covers an area approximately 100 kilometers square in north-central Chile. It includes in its north-central portion the desert mining center of Copiapó, and along its Pacific coast the port city of Caldera. The area was examined for a period of about two weeks during October and November 1958 by geologists of the U. S. Atomic Energy Commission and the Instituto de Investigaciones Geológicas de Chile for the purpose of evaluating known uranium occurrences and determining the over-all potential of the region for uranium. Occurrences of uranium in the Copiapó area were found in: high-temperature veins in the Coast Range; high-temperature mineral deposits in breccia pipes in the central area; low-temperature veins in the central area; and carbonaceous layers in late Tertiary to Quaternary stream-terrace gravels in the Andes. No minable deposits of uranium were found as a result of the reconnaissance, and all known occurrences of uranium minerals are small or of low grade. It was concluded that the uranium potential of the base- and precious-metal areas is low, based on the observation that uranium apparently has accompanied other metals only as a minor or trace constituent. It is believed, however, that the sediments peripheral to the base-metal areas may be favorable for the accumulation of uranium. (auth)

33278 (UAG-R-112) A STUDY OF MAGNETIC STORMS AND AURORAS. Scientific Report No. 7. Syun-Ichi Akasofu (Alaska. Univ., College. Geophysical Inst.) and Sydney Chapman (Alaska. Univ., College. Geophysical Inst.; High Altitude Observatory, Climax, Colo.; and Michigan. Univ., Ann Arbor. Inst. of Science and Tech.). Mar. 1961. 209p.

New notations for magnetic disturbance fields are proposed, based on the theoretical consideration of the electric current systems by which they are produced. A typical magnetic storm begins suddenly when the onrush of the front of the solar gas is halted by the earth's magnetic field. This effect (DCF field) is most markedly observed as a sudden increase of the horizontal component of the earth's field (the storm sudden commencement, abbreviated to ssc) like a step function. In many cases, however, the change of the field during the ssc is more complicated, and different at different places. Such a complexity superposed on the simple increase (DCF) is ascribed to a complicated current system generated in the polar ionosphere (DP current). It is found that the changes of electromagnetic conditions in the polar regions are communicated, without delay, to lower latitudes, even down to the equatorial regions. It is inferred that the equatorial jet is affected by such a change and produces the abnormal enhancement of ssc along the magnetic dip equator. From the extensive analysis of several magnetic storms that occurred during the IGY and IGC, it is suggested that the capture of the solar particles in the outer geomagnetic field occurs when irregularities, containing tangled magnetic fields and high energy protons embedded in the solar stream, impinge on the earth. Thus the development of a magnetic storm depends on the distribution of such irregularities in the stream. The motions and resulting currents and magnetic fields of such trapped solar particles are studied in detail for a special model. It is inferred that a large decrease (DR field) must follow the initial increase; it is ascribed to the ring current produced by such motion of solar protons of energy of order 500 Kev. It is proposed that during the storm there appears a transient storm-time belt well outside the outer radiation belt. It is predicted that the earth's magnetic field is reversed in limited regions when the ring current is appreciably enhanced. This involves the formation of neutral lines there. These may be of two kinds, called X lines or 0 lines according as they are crossed or encircled by magnetic lines of force. These may be entirely separated or may be joined to form a loop, called an OX loop. It is shown that one of them, the X line, which is connected with the auroral ionosphere by the lines of force, could be the proximate source of the particles that produce the aurora polaris. By postulating the existence of such X-type neutral lines at about 6 earth radii, an explanation is obtained of the detailed morphology of the aurora. This includes the auroral zones and their changes, the nighttime peak occurrence of auro-

ras, their thin ribbon-like structure and their multiplicity, their diffuse and active forms and the transition between them (break-up), the required electron and proton flux, and the ray and wavy structures. Among the most important phenomena associated with the sudden change of the aurora from the diffuse to the active form are the simultaneous appearance of the auroral electrojet and the resulting polar magnetic disturbances (DP sub-storms). Several typical DP sub-storms are studied in detail. It is concluded that a westward auroral jet is produced by a southward electric field. It is shown that an instability of the sheet-beam issuing from along the X-type neutral line can produce a southward electric field of the required intensity. The southward electric field produces an eastward motion of the electrons in the ionosphere. This may be identified with the eastward motion of an active aurora and with the westward auroral electrojet. Besides such large changes of the field, there often appear various quasi-sinusoidal changes of the field, much less intense. They are supposed to be hydromagnetic waves, some of which are generated in the outer atmosphere and propagated through the ionosphere, where a certain amount of their energy is dissipated. It is concluded that such a dissipation is not sufficient to produce any appreciable heating of the ionosphere. (auth)

33279 (AEC-tr-5404) USE OF NUCLEAR PHYSICS IN SURVEYING AND EXPLOITING OIL AND GAS DEPOSITS. G. N. Flerov. Translated from p.117-22 of "Proceedings of the Conference on Radioisotopes in the Physical Sciences and Industry, held in Copenhagen, September 6-17, 1960. Vol. I" (a publication of the International Atomic Energy Agency, Vienna, 1962). (STI/PUB/20(Vol.I(p.117-22)). 5p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, as abstract no. 16043.

33280 (CEA-tr-R-1522) ETAT ACTUEL DU CONTROLE DE LA RADIOACTIVITE DES EAUX. (Present State of Monitoring Radioactivity of Water). H. Kiefer and R. Maushart. Translated into French by Z. Horusitsky. Published in German in Neue Tech., 2: No. 3, 42-5; 3: No. 4, 12-16(1960). 44p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract nos. 20461 and 20462.

33281 THE EXPERIMENTAL DETERMINATION OF RADIUM, THORIUM AND POTASSIUM IN ROCK SPECIES BY AERIAL SURVEYS WITH SINGLE CRYSTAL, NaI(Tl) SCINTILLATOR. L. I. Boltneva, V. N. Vasilenko, A. V. Dmitriev, V. A. Ionov, I. M. Nazarov, and I. V. Yagodovskii. At. Energ. (USSR), 13: 280-2(Sept. 1962). (In Russian)

The method of determining radium, thorium, and potassium by airplane surveys with plastic scintillators over areas with relatively simple geological formations, which was previously reported, was extended and implemented by the use of a multi-channel, gamma spectrometer, utilizing a single crystal NaI(Tl) ($4\frac{3}{4}$" dia. × 3" height). In addition, surveys were carried out at three altitudes, 25, 50, and 100 meters, as opposed to measurements which were made at a single altitude of 25 meters in the previous work. The concentrations are determined on the basis of three simultaneous equations where the coefficients are evaluated over three energy ranges from 1.3 to 1.6 Mev; from 1.6 to 2.2 Mev; and from 2.5 to 2.8 Mev. The precision with NaI(Tl) is about 10% and is an improvement over the use of the plastic scintillator. The results obtained at heights of 50 to 100 meters are in error by 20 and 50%, respectively, but, after normalizing the coefficients for these heights to 25 meters, the statistical divergences due to different heights do not exceed 5%. Some large divergences (10 to 15%) were observed between the determinations of radioactive elements by airplane surveys as compared with the results of surface analyses. The statistical precision for the determination of the concentration by repeated traverses (10 to 60 separate observations) over a particular complex is of the order of 3 to 5%. Over areas of relatively simple geological formation, the determinations of the concentrations of Ra, Th, and K by aerial surveys with standard crystals at heights of 25 to 100 meters can be carried out with a high degree of confidence. (TTT)

33282 SOME RADIOACTIVE ANOMALIES IN THE VICINITY OF CERRO VERDE, AREQUIPA. Bol. inform. junta control energia atomica (Peru), 7: No. 39, 44-52 (May-June 1962). (In Spanish)

Radioactive reconnaisance was made in the vicinity of Cerro Verde, Arequipa, and the geology of the region was studied. Abnormal radioactivity readings were found in granite outcroppings. A geological chart of the region is inserted. (J.S.R.)

33283 ON THE TERRESTRIAL OCCURRENCE OF ELEMENT 43: TECHNETIUM. Bernard Thomas Kenna (Univ. of Arkansas, Fayetteville). Dissertation Abstr., 23: 427-8(Aug. 1962).

Since Mo^{99} was isolated from pitchblende and the mass-99 chain fission yield determined to be 6.3 ± 0.6%, it was expected that naturally occurring fissiogenic Tc^{99} would also be present. The method by which naturally occurring Tc was sought and found is given. The absorption half-thicknesses of the samples (average value, 7.22 ± 0.25 mg Al/cm^2), obtained through absorption studies, were in agreement with the accepted half-thickness value for Tc^{99} (7.2 mg Al/cm^2). An attempt to weigh the Tc yielded negative results, which excluded the presence of weighable quantities of primordial long-lived Tc. The amount of Tc^{99} was estimated by considering the spontaneous fission of U^{238} and the slow neutron induced fission of U^{235}. Experimental results were within the ±30% error limits involved in determining the estimate and, therefore, were in fair agreement with the estimated value. (P.C.H.)

33284 THE DYNAMICS OF THE TRANSPORT OF RADIOACTIVE AEROSOLS OVER FRANCE. Tovy Grjebine and Gérard Lambert (Centre d'Études Nucléaires, Saclay, France). Geofis. pura e appl., 50: 203-15(1961). (In French)

The data analysis of eighteen stations located in France showed the possibility of distinguishing several main types of transport. The first type of transport shows a perfectly regular and homogeneous distribution of radioactive debris in clouds. The second type of transport results in a regular distribution debris over the country independent of the clouds systems. In the third type the debris is distributed irregularly and the fall-out is perfectly independent of the cloud-rain system. The three types follow each other in a way continuous with time. The irregular and independent-transport type immediately follows the explosions. The regular distribution of debris, but still independent of the cloud system, comes later and the debris will be mainly of tropospheric origin. The irregular and non-homogeneous distribution of debris will be characteristic of recent explosions and correspond to fall-out of tropospheric origin. (auth)

33285 APPLICATION OF NUCLEAR-BOMB DEBRIS AS TRACER FOR STUDIES OF WEATHER SYSTEMS. P. B. Storeboe (Air Force Cambridge Research Labs., Bedford, Mass.). Geofis. pura e appl., 50: 222-8(1961). (In English)

The meteorological analysis of weather situations during which radioactive samples were collected, is described. It appears that precipitation washes out significant part of the radioactive particles in the air. Successive samples from weather systems revealed that when precipitation was produced in the warm air mass only, the radioactivity concentration in the precipitation decreased with time and was independent of location. In order to explain this, a new weather system model is proposed, in which the main part of the precipitation is produced by uniform lifting of a warm air tongue. (auth)

33286 SIZE DISTRIBUTION OF NATURALLY OCCURRING RADIOACTIVE DUST MEASURED BY A CASCADE IMPACTOR AND AUTORADIOGRAPHY. M. Kawano (Electrotechnical Lab., Tokyo) and S. Nakatani. Geofis. pura e appl., 50: 243-8(1961). (In English)

The size distribution of dust particles suspended in the atmosphere near the ground which carry the naturally occurring radioactive substances was studied by the cascade impactor and autoradiography, i.e., the cascade impactor was used for classifying the dust particles into 4 groups by their particle sizes, and the autoradiography was used for counting the number of alpha tracks on each stage of the impactor at 0 hrs and 18 hrs after collection. According to the results of measurements, a large part of naturally occurring radioactive dust was concentrated in the size range below 0.5μ, and the radioactivity was radiated almost solely from radom and thoron daughter products of short half lives. (auth)

33287 THE INVESTIGATION OF NATURAL RADIOACTIVITY OF CLOUD ELEMENTS AND A RELATED PROBLEM. B. J. Styra (Geological-Geographysical Inst., Academy of Sciences, USSR). Geofis. pura e appl., 50: 249-59(1961). (In German)

During a number of years at Vilnius the sounding of clouds was carried out from airplanes in order to study the contents of radioactive materials accumulated in cumuli. Two methods for taking samples were used: 1)the collection on cooled surfaces and 2) the method of filter paper covered with erythrosin and kept in a special collector within the Venturi tube. In the first case radioactivity was measured with the help of Geiger-Mueller counter and in the second by means of nuclear photo emulsion (sensitive to α-particles) which was brought into contact with the filter paper moistened in the cloud. This method made it possible: 1) to measure radioactivity in local zones of a cloud, 2) to measure radioactivity of separate big drops, and 3) to study the composition of α radioactivity contained in cloud particles. The magnitude of specific radioactivity of cloud elements appears to be of the same order with the rain drops and at times even greater than that of the rain samples. There exist two types of the distribution of radioactivity in a cumulus according to the height: 1) an increase of radioactivity from the bottom to maximum at the height of 0.6 part of the cloud's thickness and 2) two maxima of radioactivity at the bottom and in the center. The latter phenomenon is characteristic of thick cumuli where big radioactive drops apparently fall out from the center. The distribution of radioactivity at different heights correlates well with cloud's liquid water. In a cumulus there takes place a process of accumulation of radioactive aerosol with the accumulation coefficient of 1000. This circumstance points to a very important part played by clouds as accumulators of radioactive materials from the air which continuously filters itself through them. And just by this is expressed one of the properties of clouds as purifiers of the atmosphere from radioactive aerosol, for, as theoretical calculations indicate, the ability of drops to absorb radioactive aerosol diminishes with the process of cloud droplets growing to the size of rain drops. The composition of radioactive materials in cloud elements is very complex. In drops there appear nearly all the natural radioactive elements (emitting α particles) which exist in the earth's crust. (au'-')

33288 THE ACCUMULATION OF NATURAL RADIONUCLIDES ON AEROSOL PARTICLES AND PRECIPITATION ELEMENTS IN THE ATMOSPHERE. W. Jacobi (Hahn-Meitner-Institut für Kernforschung, Berlin). Geofis. pura e appli., 50: 260-77(1961). (In German)

The attachment of Rn- and Tn-decay-products to the atmospheric aerosol is discussed, taking into account diffusion and electrostatic forces. The computed size distribution of the produced radioactive aerosol agrees with the results of diffusion measurements. The activation of cloud and rain droplets with short-lived decay products is chiefly due to the diffusion of fresh, carrier-free RaA-atoms. The collection efficiency of falling rain droplets for RaA and ThB was measured in model experiments; it is small compared to the activation of cloud elements. A method for the continuous measurement of RaB- and RaC-activity during rainfall is described: the measured, mean specific activity of $3 \times 10^{-5}\mu c/cm^3$ can be explained by the theory of activation processes. (auth)

33289 MEASUREMENT OF THE DEPOSITION OF SUBMICRON PARTICLES IN GRADIENTS OF VAPOUR PRESSURE AND OF THE EFFICIENCY OF THIS MECHANISM IN THE CAPTURE OF PARTICULATE MATTER BY CLOUD DROPLETS IN NATURE. P. Goldsmith, H. J. Delafield, and L. C. Cox (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Geofis. pura e appl., 50: 278-80(1961). (In English)

When diffusion of a vapor in a gaseous medium occurs, any particles suspended in this gaseous mixture will move along the vapor pressure gradient because of the force exerted on them by the diffusing vapor molecules. This effect was first demonstrated by Facy for particulate matter near growing and evaporating water drops. Quantitative measurements of the velocity, imposed on radioactively marked sub-micron particles (0.03 to 0.1 μ radius), in controlled gradients of water vapor pressure are described. The particle velocity is shown to be a linear function of the vapor pressure gradient over the range measured, such that: $V_p = 2 \times 10^{-4}$ (dh/dx), where V_p is the velocity imposed on the particles (cm/sec), dh/dx is the water vapor pressure gradient (mb/cm). The efficiency for this mechanism in the capturing of the atmospheric aerosol by condensing droplets is considered in the light of these measurements. It is concluded that the fraction of submicron particles captured by growing droplets in a cloud is generally low. For instance, 100 water droplets per cc growing to 10 μ radius would capture about 5×10^{-4} of the particulate matter in the surrounding air. Direct experimental verification of this conclusion is presented. In a cloud chamber, droplets were grown up to about 10 μ radius on salt nuclei in an atomosphere containing about 5,000 submicron particles per cc. The particles were again marked radioactively, and autoradiographic techniques, capable of detecting one marked particle, were used on samples of the droplets obtained by cascade impactor. The autoradiographs showed that the fraction of the particles captured during the growth of the droplets was less than 10^{-3} per 100 droplets per cc. (auth)

33290 DETERMINATION OF THE ABSOLUTE GEOLOGICAL AGE OF THE ALKALINE COMPLEXES OF THE MIDDLE URAL WITH THE AID OF THE LEAD-ISOTOPIC AND THE POTASSIUM–ARGON METHODS. S. L. Mirkina,

E. K. Gerling, and Yu. A. Shukolyukov. Geokhimiya, No. 8, 643-8(1962). (In Russian)

The age of the alkaline complexes of the southern and northern parts of the Middle Ural determined with the aid of the K/Ar method on micas is 280 million years. The U, Th, Pb content was determined and the Pb isotopic analysis was carried out on 13 radioactive minerals. The calculation of the age by the usual Pb/U method with a correction for common lead according to galena gave strongly diverging results. In the system of coordinates Pb^{206}/Pb^{204} – Th^{232}/Pb^{204}, Pb^{206}/Pb^{204} – U^{238}/Pb^{204}, and Pb^{207}/Pb^{204} – U^{235}/Pb^{204} the experimental data form straight lines. According to the straight line inclination tangent the age values were calculated as 295, 275, and 230 million years, respectively with an average of 267 ± 24 million years. The isotopic composition of the captured common lead was also computed. (auth)

33291 ON THE MECHANISM OF HELIUM ISOLATION FROM METAMICT ZIRCONS. A. V. Karyakin (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, Moscow). Geokhimiya, No. 8, 660-4(1962). (In Russian)

Metamict zircons were examined with the aid of paramagnetic electronic resonance and infrared absorption spectra. The presence of F- and V-color centers was established in metamict zircons which arise under the action of radioactive radiation and are destroyed at irradiation by fast electrons and ultraviolet light. On the basis of the obtained experimental data a mechanism of the formation of helium atoms and α particles is proposed. (auth)

33292 URANIUM AND THORIUM IN GRANITOIDS OF THE KAIB MASSIF (CENTRAL KAZAKHSTAN). L. V. Dmitriev and L. L. Leonova (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, Moscow). Geokhimiya, No. 8, 665-72(1962). (In Russian)

In granitoids of the chief phase, the phase of additional intrusions and in vein rocks of the first stage of the Kaib massif (Central Kazakhstan) the uranium and thorium content is constant and equals 2.5 — 3γ and Δ — ~ 24γ respectively. The vein rocks of the II stage contain the least amount (~ 1γ) of uranium. An enrichment in uranium occurs only in the postmagmatic stage in the process of greysening or high-temperature silicification. The interaction of the granite melt with intruding rocks (formation of the hybrid facies and the facies of heightened alkalinity) does not influence the uranium and thorium distribution. (auth)

33293 ON THE FORMS OF URANIUM OCCURRENCE IN UNDERGROUND WATERS AND THE CONDITIONS OF ITS DEPOSITION IN THE FORM OF UO_2. A. K. Lisitzin (Inst. of Geology, Petrography, Mineralogy, and Geochemistry, Academy of Sciences, Moscow). Geokhimiya, No. 9, 763-9(1962). (In Russian)

For estimating the forms of uranium in underground waters, physicochemical constants of its equilibrium in aqueous solutions were used. It is shown that in weak acid, neutral, and alkalescent underground waters of different mineralization anionic forms of uranium prevail in the form of di- and tricarbonateuranyl. The values Eh of the equilibrium in solution with UO_{2sol} are in accordance with the results of detailed hydrogeochemical observations and analyses. The value Eh of the beginning of precipitation of the tetravalent uranium oxide from underground waters ranges approximately from 0 to −0,2 volt depending on the uranium concentration in solution, the magnitude and character of the total mineralization of water, the pH, and the concentration of HCO_3^--ion. (auth)

33294 URANIUM AND THORIUM IN ALKALINE ROCKS OF THE URAL. E. M. Eskova, D. A. Mineev, and I. G. Mineeva (Inst. of Mineralogy, Geochemistry and Crystal Chemistry of Rare Elements, Academy of Sciences, Moscow). Geokhimiya, No. 9, 770-7(1962). (In Russian)

The U and Th distribution in various types of alkaline rocks of the Ural and South Mugodzhary was studied. For most of the investigated massifs the thorium content was near the average thorium content in the earth's crust, but the uranium content is heightened in comparison to the earth's crust. Variations of the Th/U ratio are entirely connected with the change of the U-content. A direct correlation of the contents of radioactive elements with rare earths and to a smaller degree with Nb and Zr was established. (auth)

33295 METHOD OF DETERMINING THE LONG-LIFE ACTIVITY CONTENT OF ATMOSPHERIC AEROSOLS FROM THE CHANGE IN THE HALF-LIFE PERIOD OF THORIUM-B. Khr. Kamburov. Izv. Fiz. Inst. Aneb, Bulgar. Akad. Nauk., 9: 105-7(1961).

Description of the method is given. (P.C.H.)

33296 THE GAMMA SPECTROMETRY OF THE ATMOSPHERIC FALL-OUT. Vratislav Havlovic, Vilém Santholzer, and Jirí Macku (Kharkov Univ.). Jaderná energie, 8: 235-8(July 1962). (In Czech)

Recent and several years old samples of atmospheric fall-out were analyzed by means of a scintillation gamma-spectrometer. In the mixture of fission-products the nuclides radiating gamma rays were thus specified. From the spectra, it is concluded that the composition of fission-products depends on the age of the sample. (auth)

33297 WIDESPREAD IONOSPHERIC DISTURBANCES DUE TO NUCLEAR EXPLOSIONS DURING OCTOBER 1961. Tatsuzo Obayashi (Kyoto Univ.). Nature, 196: 24-7(Oct. 6, 1962).

A series of Soviet nuclear tests made during Oct. 1961, at Novaya Zemlya revealed evidence of strong blast waves propagating through the ionosphere over a considerable distance. The time variations of traveling disturbances at key stations and field strength records at the Hamburg-Osaka route were used in the analysis of two events on Oct. 23 and 30. The traveling disturbance was confirmed in India and in South-east Asia. Both events were quite similar, except for a more turbulent condition for the second one. The speed of these traveling disturbances was 400 to 500 m/s. In spite of such widespread effect over the Eurasian continent, little or no effect was noticed at North American stations. Analysis of data indicates the disturbance had its origin in propagating atmospheric waves controlled by gravitational and compressional forces. The internal atmospheric wave appeared to be of two types, with behavior in the high-frequency range resembling an acoustic wave, while in the very low frequency range the gravitational forces introduced a profound anisotropy and it resembled a gravity wave. Data indicate that the acoustic waves propagate more or less isotropically, while the gravity waves tend to propagate in the horizontal direction. A schematic illustration is presented of the wave motions, together with the horizontal velocity profile of the gravity waves at representative periods. It is shown that the amplitude of waves grows exponentially with increasing height until the dissipation dominates over this and a shock wave may develop near the upper fringe. The transportation of the wave energy to very long distances is discussed. (C.H.)

33298 NUCLEAR EXPLOSIONS AND NORMAL MODE OSCILLATIONS OF THE EARTH. H. M. Iyer (Meteorolog-

ical Office, Bracknell, Berks, Eng.). Nature, 196: 55(Oct. 6, 1962).

The suggestion that nuclear explosions can excite the normal mode oscillations of the earth is discussed. It is pointed out that free oscillations of the Earth have been experimentally observed on only two occasions. Fifty-seven minute waves on strain seismograph records were observed after the Kamchatka earthquake of Nov. 4, 1952, and the great Chilean earthquake of May 22, 1960, also caused very noticeable oscillations and several of the spheroidal and toroidal modes of the Earth were detected and identified from gravity meter and strain seismograph data. The energy demand to excite normal mode oscillations of the Earth is enormous and hence only very large earthquakes cause noticeable effects and even then very sensitive instruments are required to detect them. The Kamchatka earthquake had a magnitude of 8.25 and the Chilean earthquake had a magnitude of 8.75. These magnitudes correspond to an energy release of the order of 10^{27} ergs. The largest nuclear bomb exploded so far communicated energy of the order of 10^{20} ergs to the ground. This is equivalent to an earthquake of 5.5 to 5.75 magnitude. It is concluded that this amount of energy will not excite free oscillations on the Earth. (C.H.)

33299 RADIOAKTIVNYE IZOTOPY I YADERNYE IZLUCHENIYA V NARODNOM KHOZYAISTVE SSSR. (Radioactive Isotopes and Nuclear Radiation in the National Economy of the USSR). Radioaktivn. Izotopy i Yadernye Izlucheniya v Nar. Khoz. SSSR, Tr. Vses. Soveshch., Riga, 1960, 4: 1-284(1961).

Thirty-eight papers are included. The papers deal with applications of radioactive methods in prospecting and exploration of mineral deposits, radiometric studies, and ore enrichment technology. (R.V.J.)

33300 TRITIUM AND HELIUM-3 IN SOLAR FLARES AND LOSS OF HELIUM FROM THE EARTH'S ATMOSPHERE. E. Flamm, R. E. Lingenfelter, Gordon J. F. MacDonald, and W. F. Libby (Univ. of California, Los Angeles). Science, 138: 48-50(Oct. 5, 1962).

He^3 and H^3 found in the casing of the earth satellite Discoverer XVII flown following the Nov. 12, 1960, solar flare are probably due to the satellite intercepting some of the flare radiation. The results indicate that a large part of the He^3 and a significant fraction of the H^3 in the earth's atmosphere are accreted from the sun. Calculations are made on the yields of He^3 and H^3 in the solar flare and on the rate of escape of He^3 from the atmosphere. (D.L.C.)

33301 FISSION PRODUCT RADIOACTIVITY IN THE NORTH POLAR STRATOSPHERE. P. F. Gustafson (Argonne National Lab., Ill.), R. B. Keener, G. A. McGinnis, and R. A. Soller. Science, 138: 433-4(Oct. 19, 1962).

Balloon-borne gamma-ray detection equipment flown from Thule, Greenland, during April 1962, indicated that there was considerable radioactivity above 70,000 feet. Gamma-ray spectra obtained indicated the source of much of the activity to be the Soviet nuclear tests in late 1961. (auth)

33302 THE DISTRIBUTION OF DISPERSED ELEMENTS AMONG THE COMPONENTS OF RESERVOIRS. I. SOME GENERAL CONSIDERATIONS. N. V. Timofeyev-Resovskii. Trudy Inst. Biol., Akad. Nauk S.S.S.R., Ural' Filial, No. 12, 189-93(1960).

The development of the discipline of biogeocenology concepts of the biosphere and biogeochemistry is traced. The function of biogeocenology is to study the balance of the energy and chemical elements of living and stagnant components within the confines of biogeocenosis. The development of experimental biogeocenology is essential. The function is to create artificial biogeocenoses, to isolate small natural areas of accurately known biogeocenological composition which can be experimentally subjected to definite energetic factors, have controllable substances introduced, or be exposed to qualitative or quantitative changes in assemblages of living organisms. An important line of research is exploration of the differences in the biogeochemical meshanisms in water bodies and on dry land. One of the special tasks of experimental biogeocenology of reservoirs is the study of radioactive pollution of natural waters and possible methods of their biological purification and deactivation. (OTS)

HEALTH AND SAFETY

Refer also to abstract 32901.

33303 (AERE-R-4142) THE CLINICAL URINE EXAMINATION AND THE INCIDENCE OF MICROSCOPIC HAEMATURIA IN APPARENTLY NORMAL MALES. C. Sanders (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Aug. 1962. 14p.

The results are given of a full clinical urine examination on 725 male employees including the microscopical examination of the centrifuged deposit. The results show that the incidence of microscopic hematuria is greater than would be expected since a high percentage of the individuals examined show no evidence of proteinuria. Urine samples with no evidence of proteinuria are not normally centrifuged and examined microscopically. (auth)

33304 (ARCRL-7) INTERIM REPORT ON RADIOACTIVITY IN DIET. (Gt. Brit. Agricultural Research Council. Radiobiological Lab., Wantage Berks, England). May 1962. 10p. (A/AC.82/G/L.771)

Data are tabulated from a country-wide survey of Sr^{90} from fall-out in the average mixed diet of the population of the United Kingdom during 1961, I^{131} in milk samples collected between Dec. 1961 and April 1962, and Sr^{90} levels in milk samples collected during the last half of 1961. (C.H.)

33305 (BLG-68) CONDITIONS DE TRAVAIL ET DE SECURITE DANS LES LABORATOIRES DU SERVICE DES RADIOISOTOPES A MOL. (Working Conditions and Safety in Radioisotope Production Laboratories at Mol). R. Constant and J. Mekers (Brussels. Centre d'Etude de l'Energie Nucleaire). Dec. 1961. 49p.

The rules adopted in the radioisotopes production laboratories of the CEN are discussed. The aim of these rules is to protect the individuals against the hazards of irradiation and contamination. The safety measures taken to prevent any incident connected with the manipulation of radioisotopes are also described. (auth)

33306 (CNI-73) NOTIZIE SULLA IDROGEOLOGIA E SULL'APPROVVIGIONAMENTO IDRICO NELLA ZONA CIRCOSTANTE IL CENTRO NUCLEARE DI ISPRA (1960). (Information on the Hydrogeology and Hydric Supply in the Area Surrounding the Nuclear Center of Ispra (1960)). M. Garofano (Italy. Comitato Nazionale per l'Energia Nucleare. Centro di Studi Nucleari, Ispra). Dec. 1961. 63p.

An investigation was made of the hydrogeology and water supply in the area surrounding the nuclear center of Ispra, within a radius of 10 kilometers from the nuclear reactor Ispra-1. The aim of the inquiry was to make possible, by a better knowledge of the hydric vehicle, the prevention or reduction of the dangers represented by the radioactive contamination of ground and water, that could be caused by nuclear installations. It was demonstrated that in the area examined, the soil is in some parts loamy with low permeability and good capacity of ionic exchange, while in others it is sandy with a great permeability and small capacity of ionic exchange. The telluric water is abundant and latent, but more frequently it outcrops; there are also watery sills, which are real underground brooks. The numerous lakes of the area have impermeable walls, which prevent direct communications between geographic and telluric water. Stratum springs secure the greatest part of the hydric supply for the population. Geographic water is scarcely used for drinkable purposes. Therefore, while the danger deriving from radioactive contamination of geographic water is very low, the danger represented by the radioactive contamination of telluric water is not negligible. (auth)

33307 (CNI-106) CONCENTRAZIONE DI RADIOATTIVITÀ PRESENTE IN ALCUNE SPECIE DI PESCI COMMESTIBILI DEL LAGO MAGGIORE (1959). (Concentration of Radioactivity Present in Some Species of Edible Fish of the Lago Maggiore (1959)). A. Pugliese and L. Vido (Italy. Comitato Nationale per l'Energia Nucleare. Centro di Studi Nucleari, Ispra). 1961. 19p.

During the months of March to May 1959, before the nuclear reactor Ispra-1 started its work, fish samples from 5 fishing zones of the Lago Maggiore were collected and 10 eatable fish species were selected including Alosa finta var. lacustris Fatio, Coregonus wartmanni coeruleus Fatio (e Coregonus schinzi-helveticus Fatio), Salmo fario var. lacustris Linn., Anguilla vulgaris Cuv., Alburnus alborella De Filippi, Tinca vulgaris Cuv., Scardinius erythrophthalmus Linn., Esox lucius Linn., Lota vulgaris Cuv., and Perca fluviatilis Linn. Using suitable methods, here described, total beta radioactivity, activity of Cs^{137} and activity of Sr^{90} were measured in the sample collected. No differences in the radioactivity concentration were found among the 5 fishing zones, while significant differences were noted among the different fish species. Moreover, some connection may be observed between Cs^{137} concentration and feeding habits of fishes. The mean concentration in all the samples considered is 470 pc of Cs^{137} and 57 pc of Sr^{90} per kilogram of body weight. (auth)

33308 (HASL-131) FALLOUT PROGRAM QUARTERLY SUMMARY REPORT, JUNE 1, 1962–SEPTEMBER 1, 1962. Edward P. Hardy, Jr., Joseph Rivera, and William R. Collins, Jr. (New York Operations Office. Health and Safety Lab., AEC). Oct. 1, 1962. 242p.

Current data are presented from the HASL Fallout Program, the U. S. Naval Research Laboratory, the New Zealand Department of Scientific and Industrial Research and the Dominion X-Ray and Radium Laboratory in New Zealand. Survey information of fall-out operations in Australia is included. Radionuclide levels in fall-out, milk, tap water, and upper air samples are given in tabular form. Interpretive reports and notes dealing with strontium-90 levels in foods, 1961 global radiostrontium deposition, stable strontium in diet, statistical studies of fall-out and air sampling methods, and uranium and plutonium isotopes in fall-out are included. A bibliography of recent literature pertinent to fall-out studies is included. (auth)

33309 (HW-74398) EVALUATION OF RADIOLOGICAL CONDITIONS IN THE VICINITY OF HANFORD, APRIL–JUNE 1962. J. W. Vanderbeek ed. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 23, 1962. Contract AT(45-1)-1350. 32p.

An evaluation of radiological conditions in the vicinity of Hanford for the second quarter of 1962 indicates some reduction in calculated environmental exposures contributed by Hanford as compared with the same period of 1961. World-wide fallout increased over the same period of 1961. Natural background and fallout were the primary sources of environmental radiation exposure for most

persons in the neighborhood of the Hanford controlled area. The principal Hanford source of exposure continues to be identified with radionuclides in reactor cooling water discharged to the Columbia River. For an individual who might regularly drink Pasco sanitary water, ingest certain local fish and waterfowl, and consume produce from certain local farms, an intake of boneseeking radionuclides is estimated at about 30 percent of that recommended by the National Committee on Radiation Protection and Measurements (NCRP) as maximum for continuous intake by persons in the neighborhood of controlled areas. This is about three-fourths of the amount estimated one year ago for that exposure. The dose to the GI tract from drinking Pasco sanitary water for the twelve months ending with June of 1962 is calculated as 40 mrems, which amounts to about three percent of the recommended maximum permissible limit and is about half that estimated for a like period one year ago. Fallout from nuclear testing increased during the quarter and is attributed to the usual spring rise and the continued testing activities. (auth)

33310 (HW-SA-2590) EXPERIMENTAL PERSONNEL RADIATION DOSIMETERS. D. P. Brown and M. O. Rankin (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 21, 1962. Contract [AT(45-1)-1350]. 13p.

Two experimental pocket-size radiation dosimeters were developed to provide either an indicated measurement of accumulated dose or suitable alarming for preselected dose levels. One audibly alarms after a predetermined dose is accumulated. The second provides digital indication of the received dose on a miniature register. Both are adaptable to radiotelemetry methods of information transfer. The dosimeter which alarms has a dose range of 0–200 mr; however, with different sensors, this range can be extended up to 0–600 r. The sensor is a pencil ionization chamber modified to include an illuminated quartz fiber, an optical system, and a CdS light detector. By proper chamber charging, the unit can be adjusted to provide a suitable signal from the CdS cell after the predetermined dose is exceeded. The cell signal drives transistorized circuitry for alarming, and a second light sensor is included for temperature compensation. For the 0–200 mr ionization chamber, the alarm can be adjusted for any point from 10 mr to 200 mr. The accumulated dose can be read out at any time with a standard charger-reader. The second dosimeter uses a pencil ionization chamber sensor, modified with a quartz rod and fiber to permit automatic recharging. A pulse produced for each recharge cycle is used with transistorized circuitry to drive an incorporated miniature electromechanical register. Completed tests show that each register digit is equivalent to an accumulated dose of about 8 mr over a tested dose-rate range from 10 mr/hr to 4 r/hr. A capacitor voltage supply is used for the pencil dosimeter and the supply can be recharged with a standard pencil charger. Either experimental dosimeter will operate approximately 50 hours on one set of batteries. (auth)

33311 (HW-SA-2740) THE RADIOLOGICAL PHYSICS OF PLUTONIUM. C. M. Unruh (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 30, 1962. Contract AT(45-1)-1350. 15p.

Plutonium metal processing operations were developed with the utilization of equipment and methods to provide containment for contamination control, shields for radiation exposure control, and limitations on plutonium mass, concentration, and solution volume for criticality control. Containment of plutonium materials in glove boxes and hoods prevents the internal body deposition of plutonium radionuclides. The long biological half-life, the high energy of the emitted alpha particles, and the body's selective localization of plutonium combine to result in the low maximum permissible body burden for plutonium radionuclides. Radiation shielding is generally required to reduce personnel exposure to gamma radiation, x radiation, and neutron radiations that are emitted by the plutonium radionuclides. The specific amount of shielding required is a function of the plutonium radionuclides present, the quantity and physical distribution of the material, and the time lapse between purification and fabrication of plutonium fuel elements. High exposure plutonium from power reactors and from plutonium recycle programs will have significant quantities of the plutonium radionuclides 239, 240, 241, and, to a lesser degree, 242. The gamma radiation dose rates resulting from the daughters of Pu^{241} will increase as the daughters, americium-241 and uranium-237, build up in the processed material. Expedient fabrication of freshly separated plutonium will tend to avoid the higher gamma radiation dose rates from high exposure plutonium. The spontaneous fission rate of Pu^{240} will result in increased neutron dose rates as the percentage of this radionuclide increases. In handling of any plutonium materials, strict adherence to criticality controls is necessary. Criticality controls may be accomplished through design by the use of always critically safe vessels or by the rigid practice of administrative controls on processing operations. Although criticality control by vessel design is generally preferable, the judicious practice of both administrative and design criticality control is a common practice. The use of remote processing and handling techniques for plutonium materials is generally desirable and is encouraged. (auth)

33312 (NP-12068) RADIOEPIDEMIOLOGIC RESEARCH PROGRAM TO EVALUATE THE HAZARD TO MAN OF CURRENTLY ACCEPTED RADIATION EXPOSURE IN THE INDUSTRIAL POPULATION. I. A PILOT STUDY OF OCCUPATIONAL EXPOSURE TO IONIZING RADIATION. Semiannual Report No. 2, July 1, 1961 to December 27, 1961. Niel Wald, Albert A. Spritzer, and Allen Brosky (Pittsburgh. Univ. Graduate School of Public Health). Contract SAph-76320. 84p.

Requirements of the research program were analyzed and detailed methods were developed for obtaining and reviewing pertinent plant data. Basic equipment was acquired and chemical techniques needed for bioassay studies were developed. Measurements were made on the amount of environmental I^{131} concentrated in the thyroid glands of humans. Surveys were made on the sensitivity of film badges used as personnel dosimeters at the Westinghouse Testing Reactor and the sensitivity of the radiation detection instrument used for in-vivo thyroid I^{131} detection. (C.H.)

33313 (NP-12069) RADIOEPIDEMIOLOGIC RESEARCH PROGRAM TO EVALUATE THE HAZARD TO MAN OF CURRENTLY ACCEPTED RADIATION EXPOSURE IN THE INDUSTRIAL POPULATION. I. A PILOT STUDY OF OCCUPATIONAL EXPOSURE TO IONIZING RADIATION. Semiannual Report No. 1, December 27, 1960 to July 1, 1961. Niel Wald and Albert A. Spritzer (Pittsburgh. Univ. Graduate School of Public Health). Contract SAph-76320. 31p.

Progress is reported in the procurement of personnel and equipment for a research program to assess the occupational and non-occupational radiation exposure of the plant population at the Westinghouse Testing Reactor. A registry will be established for pertinent morbidity and mortality studies on the plant population. (C.H.)

33314 (SC-4689(RR)) A RISK-ORIENTED APPROACH TO PROTECTION FROM NUCLEAR WEAPONS. L. J. Vortman (Sandia Corp., Albuquerque, N. Mex.). Sept. 1962. Contract [AT(29-1)-789]. 56p.

A rational approach is presented for providing protection from nuclear weapons in keeping with either a policy wherein the cost of protection is borne by the individual property owner or one wherein it is borne by tax-derived funds. All prompt effects, except the scattering of prompt radiation through entrances, are given in terms of overpressure from a 10-megaton burst by providing at each overpressure sufficient cover to reduce prompt radiation to an acceptable level inside. A low radiation level inside is recommended for new construction because its additional cost is insignificant. Scattering through entrances can be reduced to acceptable levels through proper baffling and entrance door design. The thesis is that each shelter owner must find a combination of cost and risk acceptable to him. A procedure is described for estimating risk from both fall-out and blast, the latter in terms of probability of each level of blast pressure in terms of distance from likely aiming points within a target area. While oriented toward the individual, the procedures are equally applicable for shelters in commercial, industrial, and public buildings. A concept of shelters and equipment in more than one price range is introduced to permit levels of comfort and convenience to fit the wishes of the owner without any significant sacrifice of basic protection. (auth)

33315 (TID-16741) SAFE DOSES AND DOSE-RATES AND THERAPEUTIC OR PROTECTIVE MEASURES. Shields Warren (New England Deaconess Hospital, Cancer Research Inst., Boston). [Apr. 28, 1962]. Contract AT (30-1)-901. 7p.

The history of the development of standards for radiation safety is reviewed. The current rule of thumb for occupational exposure is that it shall not exceed 5 rems/yr times the number of years of age of the worker beyond 18. Those under 18 years of age are excluded from occupational exposure. This level is often considerably reduced in hospitals and atomic energy installations without sacrificing satisfactory operations. It is postulated that any radiation is harmful, and the benefit to be obtained by the useful aspects of ionizing radiation and its application to the needs of man must be weighed against the potentially harmful genetic and somatic effects. The exposure of populations throughout the world to various doses of natural background radiation and to fall-out radiation is discussed. It is pointed out that the leukemia rate in man began to rise rapidly in 1930 before there was any appreciable rise in environmental radiation, while the rate of bone sarcoma has been decreasing rapidly. No explanation of this has been presented except the improvement in diagnosis and treatment of bone sarcoma. It is emphasized that there is no remedy that can be practically used to protect man against radiation, but that once radiation damage has been entailed, the acute damage can be modified to some extent by supportive treatment. The nature of fall-out and the role of shelters in protection of the population is discussed briefly. (C.H.)

33316 (TID-16769) STUDIES ON BONE DEMINERALIZATION WITH EMPHASIS ON THE REMOVAL OF STRONTIUM. Annual Progress Report, January 1–December 31, 1962. Irwin Clark (Columbia Univ., New York. Coll. of Physicians and Surgeons). Contract AT(30-1)-2530. 11p.

Preliminary studies on the effects of Mg, Ca, and P on the removal of Sr^{89} from bone in rats showed that the effectiveness of Mg in increasing Sr^{89} elimination is dependent on the Ca/P ratio of the diet. Results also indicate that Mg metabolism is interrelated with that of Ca and P in rats. Progress is reported in studies on the effects of parathyroidectomy and hydrocortisone treatment on the intestinal absorption of Ca and P, the effects of parathyroidectomy and adrenalectomy on the intestinal secretion of Ca and phosphate, and the nature of the binding of tetracycline to bone in rats. (C.H.)

33317 (TID-16777) SAVANNAH RIVER BIOLOGICAL SURVEY LOWER THREE RUNS, SEPTEMBER–OCTOBER 1961 FOR THE E. I. DU PONT DE NEMOURS AND COMPANY. (Academy of Natural Sciences of Philadelphia). Contract AT(07-2)-1. 54p.

A biological survey was carried out of two stations on Lower Three Runs, a tributary of the Savannah River, between September 26, 1961, and October 2, 1961. The purpose of this survey was to determine whether any physical, chemical or biological changes had occurred at the Millet-Martin Station on Lower Three Runs since the last survey there in September, 1960, and to set up a new station for future comparative surveys. This survey was undertaken during the period of low flow and warm water conditions when the environment is least favorable for aquatic life. Data are tabulated. The results of these studies indicate that the aquatic life of Station L3R has definitely deteriorated since 1960 and would be classed as on the border line of a semi-healthy condition. Station TCR, which was surveyed for the first time in 1961, appears to be a healthy station with certain abnormal characteristics. (auth)

33318 (TID-16825) SOLID VS. LAMINATED LARGE STEEL SHIELDS. S. Regas, V. W. Walter (Metrix, Inc., Deerfield, Ill.); and E. C. Anderson (Los Alamos Scientific Lab., N. Mex.). [1962]. 13p.

The selection of shielding materials for large whole-body radiation counters and other low-level γ facilities is discussed from the standpoint of both economic and radiological factors. It is concluded that the use of laminated shields with plates of 2- to 3-in. thickness offer the advantages of good radiological protection, ease of fabrication by small shapes, and the use of non-specialized personnel in moving and installation. (C.H.)

33319 (TID-16826) FIRE AND EXPLOSION TESTS OF PLUTONIUM GLOVEBOXES. H. V. Rhude (Argonne National Lab., Ill.). July 1962. Contract [W-31-109-eng-38]. 11p. (ANL-FGF-342A; UAC-6669)

To test the fire and explosion resistance of new plutonium metallurgy gloveboxes and to obtain information pertinent to fire control, fire and explosion tests were conducted in one of the gloveboxes. It was found that over 10% oxygen is required for non-metal, and that over 5% oxygen is required for freely burning metal fires. However, metal chips will burn with as little as 1% oxygen if additional heat is furnished. Standard dry chemical, Met-L-X, and carbon dioxide extinguishers were excellent for non-metal fires. An eutectic salt mixture was excellent for metal fires. (auth)

33320 (WT-401) EVALUATION OF MILITARY INDIVIDUAL AND COLLECTIVE PROTECTION DEVICES AND CLOTHING. John R. Hendrickson (Chemical and Radiological Labs., Army Chemical Center, Md.). July 1952. Project 6.3-1 of OPERATION JANGLE. 70p.

Under conditions resulting from surface and underground detonations of atomic bombs, tests were conducted on Chemical Corps impregnated and unimpregnated protective clothing, Individual Protective Mask M9A1 with M11 Canister, Tank Collective Protector E26 and E22, and Protective Ointment M5. Both impregnated and unimpregnated clothing

were capable of preventing contact between the skin and radioactive dusts. Unimpregnated clothing demonstrated better contamination-decontamination characteristics, but the secondary radiation from all clothing was negligible. The protective cover was effective in preventing contamination of clothing. The M9A1 mask with M11 canister furnished complete protection against inhalation of radioactive dust. The filtering efficiencies of the E26 tank collective protectors were found to be very high, and no deficiencies were found in the unit. The filtering efficiencies of the E22 tank collective protectors were also high. Panels coated with M5 ointment were found to be much more highly contaminated than bare panels. (auth)

33321 (CEA-tr-A-1173) VALEURS MINIMALES DANS LA TECHNIQUE DE MESURE DES RAYONNEMENTS ET LEUR RAPPORT AVEC LE BRUIT DE FOND. (Minimum Values in the Technique of Measurement of Radiation and Their Relation to Background Noise). R. Plesch. Translated into French by Sté Cotec from Atompraxis, 7: 300-4(1961). 23p. (Includes original, 5p.).

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract no. 29555.

33322 HEALTH PERSPECTIVES OF OUR RADIOACTIVE WORLD: THE FIRST ANNUAL BRONFMAN LECTURE. John C. Bugher (Puerto Rico Nuclear Center, Rio Piedras). Am. J. Public Health, 52: 723-33(May 1962).

Hazards of radioactive materials to human health are discussed. (H.H.D.)

33323 SUGGESTIONS FROM A CONSTRUCTOR FOR DESIGN OF ECONOMICAL ROCK SHELTERS. Gail B. Knight (Johnson, Drake and Piper, Inc., New York). Civil Eng., 32: 37-9(June 1962).

Space needed for operation of machines, practical grades for hauling, and means for economical ventilation are outlined for blast shelters deep in rock. (Public Health Eng. Abstr., 42: No. 9, Sept. 1962)

33324 AN OPERATIONS RESEARCH STUDY OF THE POTENTIAL ACCIDENT EXPERIENCE AND TOTAL COST OF TRUCK SHIPMENTS OF HIGHLY RADIOACTIVE MATERIALS. Ferdinand Francis Leimkuhler (Johns Hopkins Univ., Baltimore). Dissertation Abstr., 23: 561-2 (Aug. 1962).

A quantitative evaluation of the nature and magnitude of the hazard to shipments by tractor-semitrailers is made and opportunities for controlling the hazard are identified. Decision models for the timing and routing of shipments were constructed and solved from the standpoint of minimizing the total cost of shipments subject to the risk of accidents with uncertain and potentially large cost consequences. Provision is made for the adoption of various attitudes in selecting appropriate measures of the accident risk. The characteristics of the accidents that can be expected with radioactive shipments were determfned from the accident experience of large interstate truckers. The results of the analysis indicate a Poisson accident frequency with significant rate variations among the seasons of the year, hours of the day, and highway conditions in different parts of the U. S. Estimates were made of the relative frequencies of accident types of direction-of-impact and of the net impact velocities in accidents. The factors are related to the dollar damage sustained by the involved truck and the total cost of accidents, both of which were found to be lognormally distributed. The proportionality of total cost to truck damage was supported by an independent study of several hypothetical accidents to radioactive shipments, and was used to derive cost estimates. A similar cost pattern was found in the analysis of the costs of various types of public disasters. Total cost models developed to express the total operating cost and the expected cost of accidents as functions of various scheduling and routing alternatives, such as: delaying shipments during the year and day, increasing route miles so as to use alternate routes and reducing the truck speed and expected impact velocity. The models were solved for optimum decision rules which balance the advantages of reduced accident rates and expected damage against the increased operating cost. The rules were evaluated over a range of possible accident costs and compared for four estimates which were taken to represent different decision-making attitudes. Recommendations are made for instituting statistical controls over present shipping operations.

33325 A STUDY OF FACTORS ASSOCIATED WITH LOSS OF DISTANT VISUAL ACUITY AMONG CHILDREN FIVE TO ELEVEN YEARS OF AGE IN HIROSHIMA AND NAGASAKI. Robert Warwick Miller (Univ. of Michigan, Ann Arbor). Dissertation Abstr., 23: 610(Aug. 1962).

An evaluation of the effects of inheritance and environment on the loss of distant visual acuity in 7117 Japanese grammar school children is presented. Unique features of the survey included: entry of the child in the study during gestation; measurement of pediatric, neurologic, and dental health, of physical and intellectual growth, and of circumstances of the in utero and home environments, and the opportunity to appraise the effects of inbreeding, since approximately half of those examined were born of parents who were second cousins or more closely related. The results showed that congenital organic lesions of the eye were very significantly higher among children of first cousins than among the outbred children. So great was the increase, it suggested that the eye is more subject to disability mediated by recessive genes than are other organ-systems. Loss of distant visual acuity in which no organic lesion was revealed by ophthalmoscopy was attributed to refractive errors; about 80% of the children with 20/70 visual acuity or worse in one or both eyes appeared to have myopia. The role of inheritance was implicated by the increasing frequency of the defects as the degree of inbreeding increased, and by the tendency for cases to aggregate in families. Effects of the environment during intra-uterine life, or soon thereafter, were suggested by the relationship of season of birth to the risk of visual acuity loss later in childhood and, independently, by the association of birth weight less than 2500 grams with an increased risk of such loss. No association was found between visual acuity loss and socio-economic status physical, neurological, or dental development, or the history or presence of illness. The age-specific prevalence rates were consistently higher in Nagasaki than in Hiroshima. The accumulated evidence suggests that myopia is attributable to a developmental flow in the sclera.

33326 CIVIL DEFENSE IN THE FOOD INDUSTRY. PART 5. MAINTAINING THE FOOD SUPPLY UNDER NUCLEAR ATTACK. Bruce M. Easton. Food Technol., 16: 34-7(Mar. 1962).

Discussion is given on the role of U. S. Department of Agriculture under the National Food Plan. (Public Health Eng. Abstr., 42: No. 9, Sept. 1962)

33327 CIVIL DEFENSE IN THE FOOD INDUSTRY. PART 6. THE ROLE OF FOOD TECHNOLOGY. H. J. McConnell (Food Drug Administration, Washington, D. C.). Food Technol., 16: 37-9(Mar. 1962).

Where the packaging material is impervious to fall-out,

war gases, or BW agents and these agents have not been covertly placed in food prior to packaging and the food packages remain intact, no harm will come from food that can be removed from a cleaned portion of a decontaminated container. Food in intact, air-tight buildings will be equally safe. Heat is the best all-around decontaminant for BW; and airing in the open in bright sunlight is one very good method for decontaminating packaged food adulterated by war gases in vapor form. (Public Health Eng. Abstr., 42: No. 9, Sept. 1962)

33328 INVESTIGATIONS ON THE QUESTION OF SILICOSIS AND NATURAL RADIOACTIVITY OF THE EARTH'S CRUST. R. Schuessler (Universität Saarlandes, Homburg, Ger.). Fortschr. Gebiete Röentgenstrahlen U. Nuklearmed., 97: 196-200(Aug. 1962). (In German)

The problem of influence of natural radioactivity of the earth's crust on the occurrence of silicosis is discussed. Measurements were carried out on miners of the Saar suffering from silicosis and on samples of dust and air in the mines. The radioactive substances were determined spectrometrically. From the preliminary results obtained, no connection appears likely between silicosis and radioactivity of the earth. Further investigations to clarify this problem are in progress. (auth)

33329 CURRENT CONCEPTS IN RADIATION PROTECTION. PART 1. Luther L. Terry (Public Health Service, Washington, D. C.) and Donald R. Chadwick. J. Am. Med. Assoc., 180: 995-9(June 23, 1962).

By distilling the best of current scientific evidence and opinion, the Federal Radiation Council has developed concepts, practical procedures, a realistic terminology, and specific radiation protection guides for official agencies concerned with environmental radiation protection. It is important that practicing physicians become familiar with the principles enunciated by the council, together with its recommended guides for fall-out radiation dosages and the ranges at which protective actions may have to be considered. Based on available evidence and authoritative predictions, present and foreseeable levels do not warrant any actions by governmental agencies designed to reduce human intake of the radioactive substances being added to the environment by such tests. (Public Health Eng. Abstr., 42: No. 9, Sept. 1962)

33330 POSSIBLE RADIATION HAZARDS ARISING FROM THE USE OF RADIOACTIVE DETECTORS IN GAS CHROMATOGRAPHY. M. P. Taylor (Radiological Protection Service, Belmont, Surrey, Eng.). J. Chromatog., 9: 28-33(Sept. 1962). (In English)

The hazards which may arise due to the use of radioactive foils in the gas chromatography detectors are reviewed; they are external radiation, effect of mechanical damage, emission of radioactive gases, the effect of chemical attack and the effect of heat. Overheating of the foils is the principle source of danger to the majority of users, but the other hazards particularly effect those persons who build or service their own apparatus. (auth)

33331 DISTRIBUTION OF RADIOSTRONTIUM AND RADIOCESIUM IN MILK AND MILK PRODUCTS. F. W. Lengemann (Cornell Univ., Ithaca, N. Y.). J. Dairy Sci., 45: 538-9(Apr. 1962).

A study was conducted to determine whether radioactive milk manufactured into butter, cheddar cheese, and cottage cheese would produce a less contaminated food. The results show a low degree of transfer of strontium and cesium from whole milk to butter. In the case of cheddar cheese and cottage cheese no marked reduction in the transfer of strontium was noted. On the other hand, the transfer of cesium was markedly reduced in both cheddar and cottage cheese. It is concluded that manufacturing techniques can be developed making it possible to utilize most of the potential food value of radioactive contaminated milk in a form lower in radionuclide content than the parent raw milk. (Public Health Eng. Abstr., 42: No. 9, Sept. 1962)

33332 RADIOACTIVITY IN HUMAN DIET. Russell R. Scott. Med. Officer, 105: 247-55(1961).

Discussion is given on the dangers to which humanity is exposed in connection with modern research in this field. Description of the research methods is given. (Public Health Eng. Abstr., 42: No. 9, Sept. 1962)

33333 RADIATION DOSES RECEIVED IN FLUOROSCOPIC CHEST EXAMINATION. R. Drion, S. Kiestra, and A. Peters. Ned. Tijdschr. Geneesk., 105: 1920-3(1961).

In order to estimate the radiation dose received by subjects undergoing fluoroscopic chest examinations at chest clinics, the exposure time and gonadal dose of scattered radiation were measured in 279 chest examinations. It was found that the mean time of exposure was 30 sec and the gonadal dose 0.075 mr for each examination. Within the direct beam, the dosage speed on the skin of the back was 4.6 r per min; with the usual diaphragm this corresponds with an integral dose of 1.2 kg roentgen. The dosages found were compared with the natural background radiation and with data obtained from studies made in Japan after the atomic bomb explosions. It was concluded that there is no need to restrict chest fluoroscopy programs at chest clinics on account of radiation hazards, provided they are carried out with due precautions. (Public Health Eng. Abstr., 42: No. 9, Sept. 1962)

33334 GRAPHS FOR DETERMINATION OF THE MAXIMUM PERMISSIBLE DOSES OF FAST NEUTRONS FROM Po + Be SOURCES. J. A. Czubek and A. Zuber. Nukleonika, 7: 419-24(1962). (In Polish)

Graphs that can be used for the determination of the maximum permissible doses obtained during work with Po + Be sources are presented. (auth)

33335 THE PROFESSIONAL RADIATION BURDEN. Hans Dresel (Universität, Freiburg i. B.). Schriftenreihe Bundesmin. Atomkernenergie Wasserwirtsch. (Munich), No. 11, 6p.(1961). (In German)

Results of an investigation of professional radiation burden in 1959 and 1960 are presented. Methods of evaluating the radiation doses are described. Accumulated doses were measured by film dosimeters and average monthly values were calculated. Sources of radiation considered were radioisotopes, x radiation, and combinations of both. The professional groups were considered in the following categories: nurses; qualified personnel, chiefly in medicine and medical research; technical employees; and assistants. Quantity and distribution of the radiation load are given in tables in terms of the maximum expected dose per month. (M.C.G.)

33336 Sr-90 CONTENT OF DUTCH FOODS. H. J. Hardon and J. W. Haken. Voeding, 23: 330-7(1962).

The average Sr^{90} content of 35 samples of bulk milk from Amsterdam in April-December 1960 was 8 $\mu\mu c/g$ Ca; for 11 samples in February-June 1961 the average was 4 $\mu\mu c$ Sr^{90}/g Ca. (Public Health Eng. Abstr., 42: No. 9, Sept. 1962)

33337 THE PROTECTIVE PROPERTIES OF A LOCALITY. Ye. Leoshenya. Voennoe Znaniya, No. 2, 23-4 (1961).

A general guide is given to military personnel on the intelligent use of natural and artificial cover from the

effects of nuclear explosions. In broken terrain, the area of destruction is approximately half that in level terrain. Mountainous regions offer the greatest possibilities for protection. As a rule, the increase in gradient is directly proportionate to the increase or decrease in shock wave pressure impact. Before utilizing local cover, the basic destructive factors of the explosion should be considered. Local objects which create shadows, such as gullies, afford good protection from the effects of light and penetrating radiation. Gullies, railroad embankments, drains, trenches, mines, ditches, and forests with thick undergrowth have very good protective properties. Forests located in broken terrain afford particularly good protection from the affects of shock waves, light radiation, and penetrating radiation. The radioactive level of the ground depends on the type of soil—for example, sandy-clay soil will absorb more radioactivity than black-earth soil after a nuclear explosion. Under frost conditions, shelters made of snow, 80–100-cm-thick, ice, or unbroken frozen earth clods of 70–80-cm-thickness, afford good protection from radiation effects. The protective properties of trenches can be increased by building roofs consisting of 40–50-cm-thick layers of earth placed on top of wooden beams or rods, boards serving as walls. Blindage consisting of a layer of earth 60–100-cm-thick has even greater protective properties. If no protective cover is available, personnel should lie face down on the ground, making sure that all unprotected parts of the body are covered. (OTS)

33338 HUMAN RADIATION HAZARDS. M. E. Wise. p.450-92 of "Physicomathematical Aspects of Biology." New York, Academic Press, 1962.

Problems involved in assessing the somatic effects of small doses of radiation in human populations are discussed. Results of estimates of total radiation doses to the whole population from all sources of man-made radiation show that radiation dose levels are rising in all countries, with the greatest contribution to this increase coming from diagnostic x rays and increased industrial exposure. Somatic effects of radiation in man include an increase in incidence of skin tumors, cancers of the bone, digestive organs, lungs and pharynx, and leukemia. It is pointed out that in all of these illnesses, except leukemia, there is usually an interval of 10 years or more between radiation exposure and onset of the disease, so there is little direct evidence that fairly small doses induce any disease. The need is stressed for both prospective and retrospective studies on radiation effects in human populations. Examples cited of studies in progress include studies on all survivors of the atomic bomb at Hiroshima, the effects of radiation from monazite sands on populations in Southern India, the effects of radioactive granite rocks on populations in New England and Scotland, and studies on the incidence of leukemia and other malignancies in various populations. Details are presented for an intensive study on the incidence of leukemia in a group of patients suffering from ankylosing spondylitis and treated with x radiation of various doses to the spine. Applications of mathematics are discussed for estimates of internal radiation dose from radioactive particles within the body, in estimates of the incidence of radioinduced leukemia for various age groups exposed to various dose levels, in estimates of the geographical distribution of bone sarcomas in the U. S., and in studies of radiation carcinogenesis in human populations. (C.H.)

INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS

33339 (HW-71319(Rev.)) SPECIAL RADIOISOTOPES FOR POWER: AVAILABILITY AND APPLICATIONS OF THORIUM-230 (IONIUM) FROM URANIUM ORE MILLS. C. A. Rohrmann (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 16, 1961. Contract AT(45-1)-1350. 43p.

Earlier reports reviewing the properties of U^{232} (and its daughter Th^{228}) emphasized favorable comparisons with other radioisotopic heat sources. It was also shown that Th^{230}, necessary for the production of these two isotopes via neutron irradiation, was available in suitable concentrations in the process streams of some U ore mills. Developments have since taken place to promote increased interest in these unique materials. Earlier work by others was declassified. Detailed information was made public for the first time on the magnitude and composition of the St. Louis Airport residues. Additional analytical results are presented along with information on the status of potential Th^{230} sources, comments on the magnitude, quality, and prospects for recovery of Th^{230} from the St. Louis residues and the other sources, thoughts on the cost of neutrons, comments on the value of Th of varying Th^{230} content, and the economic comparison between various heat source radioisotopes. (auth)

33340 (JLI-2748-0-5) BASIC AND APPLIED RADIOTRACER STUDIES. Annual Report, March 1, 1961 – February 28, 1962. William H. Johnston (Johnston (William H.) Labs., Inc., Baltimore). June 1962. Contract AT(30-1)-2748. 164p.

Construction and laboratory tests of DWICA (Deep Water Isotopic Current Analyzer) were completed, and field tests were conducted in Round Bay of the Severn River and in the Severn River. Without qualification these field tests were highly successful. Much new information about water currents in the Severn was obtained. In Round Bay current speeds and directions, which are indicated in the literature as too weak to be measured, were determined. At Annapolis, as well as Round Bay, aspects of water current movements previously unknown were measured. A pseudo-radiocarbon dating system was built and tested. This system features chemical conversion of samples to carbon dioxide which is then counted in a Geiger counter. The major cause of background fluctuations in the low level beta counting system was traced to radon concentration variations which are caused by meteorological factors. Thus, a major problem in low-level beta counting was solved. The gamma process counter was shipped to the Colorado School of Mines, after minor modification in the laboratory. Tests by the School of Mines showed that the gamma process counter is a solution to the problem of monitoring potassium concentrations in the processing of both crude and refined potassium ores. Other applications for radioisotopes were explored. A type of current analyzer was designed for use at very great depths in the ocean, for example 5000 feet. This system does not use I^{131}, and can remain in situ indefinitely without recharging. The application of neutron activation by means of multiple americium–beryllium neutron sources is being pursued with respect to: in situ generation of Dy^{165} for DWICA, activation analysis for impurities in manufactured products, and activation analysis for isotopes of short half life. (auth)

33341 (NP-12084) THE EFFECT OF CONTROL-GROUND BEEF AND IRRADIATED 5.58 MEGARAD-GROUND BEEF CONSUMPTION ON REPRODUCTIVE PERFORMANCE IN THE BEAGLE. Progress Report No. 4, September 15, 1961 – March 15, 1962. Thomas B. Clarkson and Alvin F. Moreland (Wake Forest Coll., Winston-Salem, N. C. Bowman Gray School of Medicine). Contract DA-49-193-MD-209A. 5p.

No significant differences in reproductive performance were observed in dogs maintained on a diet containing irradiated beef when compared with control groups. Data are tabulated. (C.H.)

33342 (NP-12086) THE GROWTH, BREEDING, LONGEVITY AND HISTOPATHOLOGY OF RATS FED IRRADIATED OR CONTROL FOODS (HISTOPATHOLOGICAL STUDIES). Semiannual Report No. 3. J. F. Bone (Oregon. Agricultural Experiment Station, Corvallis). July 3, 1962. Contract DA-49-193-MD-2064. 3p.

Data are summarized from histopathological studies of tissues from rats fed irradiated or control foods. No appreciable difference was seen in the pathology in the controls and the experimental animals. (C.H.)

33343 (NP-12091) COMPONENTS OF IONIZED IRRADIATED MEATS INJURIOUS TO REPRODUCTION. Progress Report. C. M. McCay, A. C. Stevens, and J. K. Loosli (Cornell Univ., Ithaca, N. Y.). July 15, 1962. Contract DA-49-007-MD-600. 4p.

Preliminary results show a slight decrease in reproductive performance in female dogs maintained on a diet containing 35% irradiated beef when compared with animals on a normal diet. No significant differences were noted in the reproductive performance in males maintained on irradiated and nonirradiated diets. Data are tabulated. (C.H.)

33344 (NP-12093) ON THE NUTRITIVE VALUE OF THE MAJOR NUTRIENTS OF IRRADIATED FOODS AND APPRAISAL OF THE TOXICITY OF IRRADIATED FOODS. Progress Report No. 21, September 1, 1961 – March 1, 1962. P. B. Rama Rao, A. M. Paolucci, Sancia Gaetani, H. E. Schendel, Roberta Hill, and B. Connor Johnson (Illinois. Univ., Urbana). Contract DA-49-007-MD-544. 30p.

Vitamin K was found to be an essential nutrient for newborn pigs fed a synthetic milk diet. Fourteen out of 15 animals developed symptoms that included highly significant increases in prothrombin time, hypersensitivity, anemia, anorexia, and weakness. The animals responded to oral or intramuscular administration of vitamin K in 2 to 4 hr. Preliminary studies on the incorporation of C^{14}-labeled amino acids into rat liver protein and the synthesis of hepatic tryptophan-pyrrolase in the liver of normal and vitamin-K deficient rats indicate that vitamin K is apparently not involved in the synthesis of proteins. Macaca mulatta monkeys approximately one year old were fed a synthetic vitamin K-free diet for periods as long as 9 months with only slight prolongation of prothrombin time. With the addition of high levels of antibiotics in the diet the animals showed signs of a somewhat greater deficiency in vitamin K, anemia, anorexia, weakness, hypersensitivity,

hemorrhage, and a prolonged prothrombin time. The monkeys responded clinically and biochemically to the administration of vitamin K at dosages as low as 0.06 μg/kg body weight. No signs of dangerous side effects were observed in monkeys that received oxytetracycline and neomycin for periods as long as 7 and 9 weeks respectively, and at dosages as great as 100 and 400 mg/kg body weight per day respectively. Applications are discussed of these findings in determinations of the nutritional value of γ-irradiated beef, which was shown to be low in vitamin-K content. (C.H.)

33345 (NP-12095) LONG-TERM RABBIT AND HAMSTER FEEDING OF IRRADIATED AND CONTROL FOODS AND ITS EFFECT UPON THE BLOOD SERUM CONSTITUENTS (PHASE 1) AND NUTRITIVE VALUE OF IRRADIATED PROTEINS AND CONTROL PROTEINS (PHASE 2). Progress Report No. 10, Six Months Ending February 28, 1962. D. F. Watson, R. M. Smibert, and R. W. Engel (Virginia. Agricultural Experiment Station, Blacksburg). Contract DA-49-007-MD-784. 14p.

Data are summarized on hematological findings, weight gain over a 6-mo period, blood serum protein values, and histopathological findings for rabbits and hamsters maintained or diets that contained irradiated carrots. Control groups were maintained on the same basic diet with unirradiated carrots. No remarkable differences in the groups were noted. (C.H.)

33346 (NP-12132) TO DETERMINE THE EFFECT OF IRRADIATION UPON THE WHOLESOMENESS OF FOOD. Progress Report No. 13, September 1961–March 1962. Om P. Malhotra, Elwood F. Reber, Roger P. Link, and Horace W. Norton (Illinois. Univ., Urbana). Contract DA-49-007-MD-72800. 17p.

Rats fed a ration containing raw pork died of hemorrhage. There was less mortality when the raw pork was replaced by roasted pork, but the results were not conclusive. The growth of the rats fed roasted pork was acutely depressed but was improved by adding methionine and cystine. Rats fed raw or roasted irradiated beef (B6) ration died of hemorrhage although the growth of the rats fed roasted B6 was acutely depressed. Amino acid (methionine, cystine, and lysine) supplemation increased the growth of the rats but had no significant effect on mortality or on the number of plasmas with prolonged prothrombin time. Rats fed B0 or B6 ration which do not contain water soluble vitamins died of starvation. B6 rats, however, died earlier than B0 rats. In the presence of water soluble vitamins, only a few rats fed B0 but almost all the rats fed B6 ration died of hemorrhage. Vitamin K at the doses used completely prevented the mortality due to hemorrhage in B0 but partially in B6 group. Supplementation of the B6 ration with amino acids and vitamins (thiamine, riboflavin, and niacin) equivalent to the quantity destroyed by radiation did not significantly influence the mortality due to hemorrhage, prothrombin time, number of plasma samples with prolonged prothrombin time, or the body weight gain. (auth)

33347 (FTD-TT-62-1033) THE PRINCIPLES OF CONSTRUCTION OF DEVICES FOR THE GENERATION OF ELECTRICAL SIGNALS OF RANDOM CONFIGURATION, USING RADIOACTIVE DECAY AS THE MASTER PROCESS. V. F. Nesteruk, N. N. Porfir'eva (Porfir'yeva), and B. A. Finagin. Translated from Izvest. Vysshikh Ucheb. Zavedenii, Priborostroenie, 4: No. 3, 135-40(1961). 10p.

The principles of construction of devices for electric generation of random signals are discussed which use radioactive decay as the master statistical process. A block diagram of a generalized telegraph signal generator is considered. It is concluded that the use of decay as the master physical process leads to simpler design and improved characteristics of devices which generate standard random processes. (J.R.D.)

33348 (NP-tr-921) PROBLEMS OF INDUSTRIAL ISOTOPE MEASUREMENT TECHNIQUES. PARTS I AND II. E. Schurz. Translated by F. Hudswell (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.) from Isotopen Tech., No. 1, 136-7; 200-3(1960/61). 23p. (Includes original, 4p.).

The economics and industrial application of isotope measuring techniques are discussed. The ranges of application of industrial isotope measuring equipment are reviewed. The method for continuous measurement of the mass per unit surface area is described. Details are given of the connection between sensitivity, accuracy, and limits of the range of measurement with reference to the voltage compensation method. (M.C.G.)

33349 EVALUATION OF CONTROL OF EUROPEAN CORN BORER, OSTRINIA NUBILALIS (HUBNER), BY X-RAY INDUCED STERILITY. John Robert Walker (Iowa State Univ. of Science and Tech., Ames). Dissertation Abstr., 23: 761(Aug. 1962).

Records on emergence from four groups of untreated European corn borer larvae, involving 11560 invividuals, showed that on the first day of emergence 50% of the moths were females. After the first day of emergence, males outnumbered females with a gradual shift to more females during the latter part of the emergence period. The sex ratio of the moths studied was approximately 57% males and 43% females. Mating studies indicated that corn borer moths had a poor to moderate fecundity level. In cages containing eight males and eight females only 67.7% of the females mated. Also only 58-88% of the eggs deposited by females in the control matings hatched. Exposure of 1-day old male moths to 32000r resulted in 1% egg hatch when they were mated to untreated females. The irradiated males competed equally with untreated males for virgin females. A ratio of eight irradiated males to four untreated males to eight untreated females resulted in 39.4% hatch of the deposited eggs. The survival of the irradiated males compared favorably with untreated males under laboratory conditions. Exposure of pupae to x rays resulted in a reduction in the percent of egg hatch as the dose was increased. Female pupae were more susceptible to the effects of irradiation than male pupae. The percent of egg hatch varied with the age of the pupae at the time of treatment, younger pupae been more susceptible to irradiation than older pupae.

33350 RADIATION-PASTEURIZED SHRIMP AND CRABMEAT. Dorothy J. Scholz (Oregon State Univ., Corvallis). Food Technol., 16: 118-20(July 1962).

The quality of shrimp and crabmeat irradiated with pasteurization doses of gamma radiation and stored at 38°F was determined by subjective evaluation, chemical analysis, and microbiological examination for total numbers of surviving organisms, and detection of pathogenic microorganisms. Quality determinations showed that the storage life of crabmeat irradiated at 0.25 megarad was extended to 3–4 weeks, compared with 1 week for unirradiated samples held at the same temperature. A dose of 0.50 megarad extended shelf life 5 weeks. Shrimp irradiated at 0.50 and 0.75 megarad remained in good condition throughout the 18-week storage period; no viable microorganisms were found, and production of decomposition products was slight as measured by the chemical tests.

Extension of shelf life was threefold. (Public Health Eng. Abstr., 42: No. 9, Sept. 1962)

33351 CONTROL OF CORD IMPREGNATION WITH RADIOISOTOPES. Max Možíšek (Research Inst. of Rubber and Plastic Tech., Gottwaldov, Czechoslovakia). Jaderná energie, 8: 242-4(July 1962). (In Czech)

The measurement of the amount of impregnant of cord was accomplished by adding P^{32}, in solution, to the impregnant of the cord. The P^{32} was in the form $Na_2HP^{32}O_4$, 0.1 mc/l. The activation of the cord was then measured by passing it between two Geiger-Mueller tubes, with the relative position of the cord accurately maintained. The penetrating beta rays of P^{32} make this method independent of cord material and, to some extent, independent of cord thickness. The accuracy of the method, after calibration, can easily achieve 2%. Gravimetric methods can be used in initial calibration, if the moisture content of the cord is carefully reduced under laboratory conditions. The difficulty in using gravimetric measurement in production control is associated with the changing moisture content of the cord in exposure to the atmosphere. Both the moisture content and the basic composition of the cord govern the amount of impregnant taken up by the cord. Careful monitoring is therefore necessary for cast and quality control. (TTT)

33352 AN INVESTIGATION OF THE POSSIBILITIES OF APPLYING IONIZING RADIATION FOR THE CONSERVATION OF SOFT FRUITS. D. I. Langerak. Kernenerg. in Landbouw, 3: 13-14(Dec. 1961).

After harvest, the quality of soft fruits, such as strawberries, raspberries, blackberries, red and black currants, cherries, and plums deteriorates rapidly, primarily because of mold damage. Conventional measures to prevent microbiological deterioration were not sufficient to prevent a loss from 6 to 18 million guilders each year from a total harvest value of approximately 60 million guilders. Therefore, the possibilities were explored for reducing the enormous economic loss by exposing the harvested fruits to ionizing radiation, giving preference to the fruits to be exported. Several methods of conservation by ionizing radiation are mentioned. For the surface sterilization of soft fruits, the Dynamitron cascade accelerator can be used. The installation cost of the accelerator was estimated to be 360000 guilders. From this estimate the total cost per hour of operation was calculated to be 60 guilders. At a dosage rate of 5×10^5 rad, 6 tons of fruits can be processed at a cost of 1 cent/kg. This compares favorably with the costs of refrigeration which lie between 2 and 4 cents/kg. (OID)

33353 SOURCES OF ALPHA-, BETA-, GAMMA- AND NEUTRON-RADIATION FOR THE CONTROL AND AUTOMATION OF TECHNOLOGICAL PROCESSES. G. M. Fradkin and E. E. Kulish. Radioaktivn. Izotopy i Yadernye Izlucheniya v Nar. Khoz. SSSR, Tr. Vses. Soveshch., Riga, 1960, 1: 95-109(1961).

The properties, characteristics, and ranges of applications of artificial radioactive isotopes are considered and the classification of γ, β, and neutron sources, as used in the USSR are given. (Referativnyy Zhurnal, Avtomatika i radioelektronika, No. 1, 1962).

33354 RADIOAKTIVNYE IZOTOPY I YADERNYE IZLUCHENIYA V NARODNOM KHOZYAISTVE SSSR. (Radioactive Isotopes and Nuclear Radiation in the National Economy of the USSR). Radioaktivn. Izotopy i Yadernye Izlucheniya v Nar. Khoz. SSSR, Tr. Vses. Soveshch., Riga, 1960, 2: 1-267(1961).

Fifty papers are included on industrial applications of radioisotopes in neutron sources in the USSR. The papers deal with applications in power engineering, construction, textile, food, paper, and coke industries. Current data on radioisotopes are given and applications in medicine and agriculture are discussed. Descriptions are given of new devices using radiation sources. (R.V.J.)

33355 RADIOACTIVE METHOD OF ACTIVE CONTROL IN AUTOMATIC STAMPING. V. T. Meshcherin, A. E. Artes, and V. A. Yanushkovskii. Radioaktivn. Izotopy i Yadernye Izlucheniya v Nar. Khoz. SSSR, Tr. Vses. Soveshch., Riga, 1960, 3: 17-22(1961).

A new radioactive method of active control in automatic sheet stamping is reported. The checking of the blank thickness on a multi-position automatic press is based on the blank passing between a source and a receiver of β radiation. If two blanks are supplied simultaneously or the thickness is increased from 1 to 1.2 mm, β radiation is fully absorbed and the electron unit stops the press. By an analogous method it is possible to sort steel blanks in the range of 0.3–1 mm, which differ by 0.2 mm in a number of gauges, using Sr^{90}. If Tl^{204} is used, it is possible to sort steel blanks in the range of 0.1–0.3 mm differing by 0.05 mm in thickness. To check the right location of large-size sheet blanks, the method of backscattering radiation is used, in which the source and receiver of β rays are on the same side of the sheet. If the blank does not block at least one spot source placed in the punch, the press is switched off and a command is given to correct the component orientation. The radioactive method is applicable for checking the presence of parts on conveyers, the presence of apertures in components, counting of parts, and measuring the distance between the block surfaces on hydraulic presses in the forging of large-size items from ingots. (Referativnyy Zhurnal, Mashinostroyeniye, No. 4, 1962).

33356 THE PRESERVATION OF THIN SKIN POTATOES WITH LOW DOSAGE X-RAYS. A. Berger and H. Hansen. Z. Lebensm.-Untersuch. u. Forsch., 117: 215-25 (May 25, 1962).

Thin skin potatoes of the Bona and Heida variety were irradiated in a shaking apparatus with an unfiltered x-ray beam from a 60-kv tube in the dosage range from 500-15000 r, and stored at 15°C and 85% relative humidity. A control sample of potatoes was stored under similar conditions without previous irradiation. It was found that lower x-ray doses previously considered necessary prevented germination and gave potatoes the appearance of new potatoes for a long time. At higher doses, shrinkage appeared to decay. Up to 10000 r no loss of vitamin C was found, but irradiation above 15000 r brought about a notable decrease in the ascorbic acid content. From an organoleptic point of view, low irradiation was much better than the application of high x-ray doses. (OID)

ISOTOPE SEPARATION

33357 (PAN-332/XIII) A METHOD FOR DETERMINATION OF YIELD OF IODINE-131 PRODUCTION PROCESS. Tadeusz Zelenay, Witold Łada, and Romuald Plejewski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). June 1962. 9p.

A method of determining the yield of I^{131} from reactor-irradiated TeO_2 is discussed. (J.R.D.)

33358 THE SEPARATION TUBE. XXIV. PREPARATION OF O_2^{18} AND THE PROBLEM OF THE ENRICHMENT OF O_1^{17}. Klaus Clusius and Kuno Schleich (Universität Zurich). Helv. Chim. Acta, 45: 1702-21(1962). (In German)

The separation of an isotopic mixture by thermodiffusion was theoretically and experimentally treated using oxygen as an example. Because of the presence of three oxygen isotopes, six types of molecules—O_2^{16}, O_{17}^{16}, O^{17}, O_{18}^{16}, O_2^{17}, O_{18}^{17}, O_2^{18}—exist. It was assumed that with separation tube wires of Pt–Ir heated to 1000°K, isotopic equilibrium such as $2\,O_{18}^{16}\,O^{18} \approx O_2^{16} + O_2^{18}$ is rapidly obtained in comparison with equilibria in a separation tube installation dependent on thermodiffusion and convection. This assumption was tested, and it was seen that within the mass spectrometer, no displacement of a given frequency ratio of the molecules occurs. The behavior of hexanary mixtures of oxygen molecules was investigated under two assumptions for the thermodiffusion factor α. In one, α in the first approximation is proportional to $(m_i - m_k)/\overline{m}$, where $\overline{m}$ is the mean mass number. In the second approximation α was assumed proportional to $(m_i - m_k)/(m_i + m_k)$. The decomposition occurring at a horizontal distance dx in the temperature field causes a proportional decomposition along a vertical separation tube element $d\zeta$. By selection of the zero position of ζ so that the O^{17} atomic concentration is a maximum, the concentration distribution of the six types of molecules can be calculated as a function of the length coordinate ζ of the separation plant. The properties of the curves obtained are discussed. The value of ζ can be empirically determined. In a separation plant of 40 m total length, 12 l of concentrate with 30 to 55% O^{18} was obtained from oxygen with 1.5 to 2.5% O^{18}. This was further investigated in a second separation plant of 24 m total length. Several liters of O_2^{18} with a purity of 99.6% emerged through the heavy end, whereas at the light end oxygen enriched in O^{18} is accumulated, and returned to the plant. In this manner the middle isotope, O^{17}, could not leave the plant so it was enriched to a maximum concentration of 6.2%. The distribution of the molecular types along the tube was measured and excellent agreement with theory was obtained in the first approximation, which was still more improved by the second approximation. From the theory guide lines are given for the obtention of O^{17} in the form of carbon monoxide. The mixed molecule N^{14} and N^{15} was proposed as an auxiliary gas which cannot be separated from $C^{12}O^{17}$ by thermodiffusion, whereas $C^{13}O^{17}$ can emerge at the light end and $C^{12}O^{18}$ at the heavy end. The necessity of a preliminary enrichment of O^{17} and the perturbing effect of C^{13} and of the Boudouard equilibrium are discussed qualitatively. (tr-auth)

33359 SEPARATIVE POWER AND OPTIMUM OPERATING PRESSURE OF GASEOUS DIFFUSION SEPARATING UNIT. Kunio Higashi, Chieko Shimizu, and Jun Oishi (Kyoto Univ.). Nippon Genshiryoku Gakkaishi, 4: 516-19 (Aug. 1962). (In Japanese)

Separative power was analyzed for a gaseous diffusion separating unit with porous membrane to obtain the optimum operating pressure of a unit. A pore of membrane was assumed to be a circular capillary having uniform radius and length, and the Present-deBethune model was applied to the flow of binary gas mixture through pores in which the non-separative flow caused by the collision of unlike molecules and the viscous Poiseuille flow as a perturbation were added to the separative Knudsen flow. In a close separation of an isotopic gas mixture at a constant temperature, the flow rate of gas through membrane and the separation factor (the separative power of a separating unit) depend only on the product (gas pressure × pore radius). Numerical calculation of the enrichment of U^{235} in UF_6 gas showed that when the separative power was plotted against (inlet gas pressure × pore radius) with a parameter of (outlet gas pressure × pore radius), a curve having a maximum point was obtained. The total number of separating units of cascade necessary for a given separative duty is a minimum when the separative power of a unit has a maximum value, and therefore the inlet gas pressure corresponding to a maximum separative power may be considered as a optimum operating pressure from the standpoint of number of separating units. It was noted that the mean free path of gas molecules may become smaller than pore radius under the optimum inlet gas pressure for the outlet gas pressure exceeding a certain value. The correlation between outlet gas pressure and the corresponding optimum inlet gas pressure was expressed in a curve, which can determine the operating condition of a separating unit. (auth)

MATHEMATICS AND COMPUTERS

Refer also to abstract 32637.

33360 (AEEW-R-90) SANDPIPER I (A COMPREHENSIVE ANALYSIS PROGRAMME FOR LIQUID MODERATED UO_2 LATTICES). R. A. Alpiar (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Apr. 1962. 48p.

Methods of calculation for light water moderated reactors were reviewed in AEEW R64. Calculation schemes for lattice parameters were presented which depended on the use of a number of IBM 704 and Ferranti MERCURY Computer Programs. SANDPIPER I is a comprehensive MERCURY program designed to cover all the operations with a degree of accuracy adequate for survey calculations. The presented version is restricted to regular or near regular UO_2 pin type lattices moderated by H_2O, D_2O, or organic liquids; it is planned to allow for greater flexibility in later versions of the program. The program is written in Autocode and requires a 4 drum machine. (auth)

33361 (HW-74100) STUDIES IN RELIABILITY. I. THE ALGEBRA OF FOUR-STATE SAFETY DEVICE. A. D. Wiggins (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 1962. Contract AT(45-1)-1350. 51p.

In the design of safety systems such as those associated with reactors, attention must be paid to modes of equipment failure. Important failures are those involving cases in which the safety system fails to perform its intended function and no corrective action is taken, and failures in which components perform unintended functions, or properly operates but at the wrong time. Attendant upon these two types of failure are two types of error which can occur with regard to system operation. First, there is the error of taking no corrective action upon the occurrence of a catastrophic type failure. Second, there is the error of taking no corrective action upon the occurrence of a spurious scram type of failure. Those who are familiar with the Neyman-Pearson theory of testing statistical hypotheses will recognize the terminology and the obvious analogues. A reliability algebra, which is seen to be a natural extension of Boolean algebra, is constructed which gives a formal recognition to these two types of error. Using this algebra it is possible to enumerate, in a systematic way, all safety system events which give rise to the errors as well as all safety system events which give rise to the two reliable states which remain. In reactor terminology these states are "catastrophic failure," "spurious scram," "operating continuity," and "genuine scram," respectively. Probabilities associated with these four states are derived by considering a simple random walk in the plane. The theory is illustrated by means of formal calculations carried out in some detail for a pair of devices operating together in a specified configuration. (J.R.D.)

33362 (LA-2729) NUMERICAL SOLUTIONS AND APPLICATIONS OF THE FOLD INTEGRAL. H. J. Longley (Los Alamos Scientific Lab., N. Mex.). July 1962. Contract W-7405-eng-36. 73p.

General numerical methods are presented for folding and unfolding. The applications to pulsed linear experimental systems are emphasized, however other applications are given. Response functions are given for specific experimental systems. Numerical examples for pulsed experimental systems are included. (auth)

33363 (NASA-TN-D-1453) A FORTRAN II PROGRAM FOR ANALYSIS OF RADIOACTIVE DECAY CURVES. John L. Need and Theodore E. Fessler (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Oct. 1962. 23p.

The program can be used to find the half-lives and the initial magnitudes of the components in a measured decay curve. Any of the components can be fixed as to magnitude and half-life and any of the half-lives can be fixed, provided that there be at least one variable remaining. The calculation proceeds by an iterative least-squares fit to the experimental data. Convergence is not guaranteed, and a stepwise approach may be necessary. The output consists of the amplitudes and half-lives of all the components together with the best estimate of the errors in those magnitudes calculated by the program. Information is also given that permits evaluation of the goodness of fit. The program can handle up to 10 components (including background) and up to 400 observations. (auth)

33364 (UCRL-10313) CURRENT PERFORMANCE OF THE ALVAREZ-GROUP DATA PROCESSING SYSTEM. Arthur H. Rosenfeld (California. Univ., Berkeley. Lawrence Radiation Lab.). June 28, 1962. Contract W-7405-eng-48. 33p.

A description is presented of the system parts which are now in satisfactory operation. Included are discussion and information on scanning and measuring, and notes on the number of men and machines involved in processing 100,000 events a year. The programs discussed include PACKAGE (a combined event-analysis program for IBM-7090), EXAMIN and SUMX (experiment-oriented programs in Fortran), Lingo (magnetic tape event catalog), FAKE (Monte Carlo test imput for the whole system), and Q (for tricky events). (J.R.D.)

33365 (UNC-5031) A DESCRIPTION OF AN IBM-7090 MONTE CARLO PROGRAM FOR THE SOLUTION OF THE TIME DEPENDENT NEUTRON AND GAMMA TRANSPORT PROBLEMS IN AN ATMOSPHERE WITH DENSITY DEPENDENT ON HEIGHT. C. Marotta and W. Guber (United Nuclear Corp. Development Div., White Plains, N. Y.). Aug. 1962. Contract DA-49-186-ORD-1012. 78p.

A report which supersedes UNC-5006 is presented. The earlier report describes an IBM-7090 Monte Carlo program UNC-90-6 for the transport of neutrons from a point, monoenergetic source in an atmosphere with density dependent on height, extending up to 700 kilometers above ground zero. The earth is treated as an absorbing surface. The neutron flux is calculated at specified detector regions as a function of time and energy. An importance sampling technique is incorporated in the program to improve statistics at detectors many mean free paths from the source. A final edit program which can be used to superpose, with specified weighting, the results of problems with various monoenergetic sources is described. Addenda are included which describe modifications to UNC-90-6 that permit the use of an anisotropic source and variable initial time for the neutron problem and which transform UNC-90-6 into a gamma ray program (UNC-90-9), and a modification to the final edit program. The modification allows for energy-dependent response function calculations. (auth)

33366 (WAPD-TM-334) CINDER — A ONE-POINT DEPLETION AND FISSION PRODUCT PROGRAM. T. R. Eng-

land (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Aug. 1962. Contract AT-11-1-GEN-14. 25p.

CINDER is a general program for use in calculation of time-dependent concentrations of nuclides coupled in an arbitrary sequence of radioactive decays and neutron absorptions in a specified neutron flux spectrum. The solution is determined for a sequence of timesteps, i.e., time intervals in which the flux and fission rate is constant; variations in the flux and cross sections are incorporated via the use of these finite time-increments. The program, for example, can be used in calculation of the time-dependent concentrations of the Hf isotopes, including transitions through the isomeric states, beginning with some initial distribution in any specified time-dependent flux. Or it can be employed in calculation of the buildup of U^{239}, Np^{239}, Pu^{239}, Pu^{240}, Pu^{241}, etc., when U^{238} is irradiated. In the latter case the concentration of fission products in chains generated by yields from fissile nuclides like U^{238} and Pu^{239} can also be calculated. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

General and Miscellaneous

Refer also to abstract 34058.

33367 (AAEC/TM-148) ELASTIC THERMAL STRESS IN REACTOR FUEL ELEMENTS—A COMPARATIVE STUDY OF VARIOUS SHAPES. Ian M. Binns (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Aug. 1962. 13p.

A method for comparison and evaluation of thermoelastic stresses is given for a range of fuel element shapes based on parameters available from the initial study of a reactor system. The shapes studied, in descending order of stress level are circular rods, concentric tubes, flat plates, and a matrix of circular holes. (auth)

33368 (ASD-TDR-62-508) DEVELOPMENT OF WORKABLE MOLYBDENUM- AND TUNGSTEN-BASE ALLOYS. M. Semchyshen, Robert Q. Barr, and G. G. Chesmar (Climax Molybdenum Co. of Michigan, Detroit). Apr. 30, 1962. Contract AF 33(616)-7930. 77p.

A number of complex Mo-, Mo-W-, and W-base alloys were consolidated by the vacuum-arc-casting technique. Difficulty was experienced in obtaining sound castings of alloys based on varying Mo/W ratios and containing nominally 1.25% Ti and 0.3% Zr. No difficulties were experienced when the Zr content was reduced to 0.1%. Carbon synergism was studied in the alloys Mo + 3% Ti + 0.5% Zr and Mo + 25% W + 1.25% Ti + 0.1% Zr. In the case of the former alloy, the optimum carbon content from the standpoint of elevated temperature strength appeared to be lower than that predicted on the basis of earlier work with Mo–Ti and Mo–Zr binary alloys. Conversely, the optimum carbon content of the latter alloy agreed well with the extrapolated forecast. In the case of both alloys, the carbon contents yielding the highest elevated temperature strengths also resulted in the highest transition temperatures. An alloy based on Mo-50% W, and containing 0.8% Ti and 0.3% Zr, displayed exceptionally high strengths at elevated temperatures. The tensile transition temperature of this material was, however, above room temperature. (auth)

33369 (BMI-X-210) GROWTH OF UO_2 SINGLE CRYSTALS. Summary Report. J. D. Jackson and C. A. Alexander (Battelle Memorial Inst., Columbus, Ohio). Sept. 17, 1962. Contract [W-7405-eng-92]. 17p.

An experimental program was undertaken to develop a means of producing single crystals of UO_2 of high purity and of sufficient size so that measurements could be made on them. Both reaction techniques and direct techniques were investigated. It was decided to concentrate effort on the direct method fusion processes. A tungsten-resistance furnace was developed which is capable of maintaining temperatures of the order of 2800°C. Samples of UO_2 were melted in the apparatus using the Bridgman drop technique. A temperature of 28020 to 2850°C was maintained for 40 min before furnace failure. Examination of the charge indicated that the crucible had not begun to drop out of the hot zone when failure occurred. Grains as large as 0.1 to 0.2-in. were obtained representing a growth of 100 to 1000 times even without proper Bridgman drop conditions. Because of impurity problems and limiting temperature capability of the furnace, a method employing the Vermeuil technique was investigated. Induction-coupled plasma was used as the power source to maintain a molten film on the UO_2. Powdered UO_2 was fed into the system by the plasma gases and impinged on the boule in a closed glass envelope. The boule was not seeded nor grown to very small size to form a single crystal. However, some crystal growth was obtained, and crystals as large as $\frac{1}{16}$-in. were observed. (M.C.G.)

33370 (BMI-X-10006) DEVELOPMENT OF URANIUM MONONITRIDE. Quarterly Progress Report, April–June 1962. Donald L. Keller (Battelle Memorial Inst., Columbus, Ohio). July 1, 1962. Work performed under United States–Euratom Joint Research and Development Program. Contract W-7405-eng-92. 21p. (EURAEC-424)

Activities in a program to examine the feasibility of UN as a reactor fuel are reported. Efforts during the quarter were devoted largely to experimental fabrication of UN bodies. Observations concerning aspects of these experiments are included. Results of other experiments concerning the preparation and properties of UN are given along with data on radiation effects. Results of phase studies, and melting and casting studies are also included. (J.R.D.)

33371 (GA-3483) THE FABRICATION AND IRRADIATION TESTING OF DISPERSION-TYPE $BeO-UO_2$ CERAMIC FUEL MATERIALS. D. E. Johnson and F. H. Lofftus (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Oct. 10, 1962. Contract AT(04-3)-187. 26p.

Considerations affecting the design of dispersion-type ceramic fuel materials are discussed. The results of measurements made to study the effect of fuel loading on the properties of the fuel bodies and the results of irradiation tests of fuel pellets composed of 20 vol % UO_2 dispersed in BeO are presented. Experience in the fabrication of dispersion-type $BeO-UO_2$ ceramic fuel materials is described. From the results obtained, it is believed that $BeO-UO_2$ fuel materials of the type studied will exhibit satisfactory performance in the Experimental Beryllium Oxide Reactor. (auth)

33372 (GEAP-3909) RARE EARTH OXIDES AND RARE EARTH BORATES-CORROSION, COMPATIBILITY, AND RADIATION EFFECTS. E. W. Hoyt, W. V. Cummings, D. L. Zimmerman, and H. E. Perrine (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Apr. 1962. Contract AT(04-3)-189. 41p.

Rare earth oxides and rare earth borates were prepared, fabricated into test pieces, and examined in environments likely to be encountered in nuclear applications. Information is presented on crystal structure, phase stability, fabrication, aqueous corrosion, and compatibility with metals, of these materials. Information on radiation effects is also given. These studies were not meant to be exhaustive, however the results should prove helpful to anyone considering using either the rare earth oxides or the rare earth borates in reactor environments. (auth)

33373 (LM/TAB-20) LIQUID METALS TECHNOLOGY ABSTRACT BULLETIN FOR THE PERIOD JANUARY 1962–SEPTEMBER 1962. (Mine Safety Appliances Research Corp., Callery, Penna.). 14p.

Thirty-three abstracts on liquid metals technology are presented. (M.C.G.)

33374 (NP-12083) THERMOELECTRIC MATERIALS. Final Report, January 28, 1959–July 28, 1960. R. G.

Breckenridge, comp. (Union Carbide Corp. Parma Research Lab., Ohio). Aug. 15, 1960. Contract NObs-77066. 17p.

A method for the measurement of thermal conductivities of electrically conducting materials at temperatures in excess of 1000°C with a high accuracy was devised. The spatial boron concentration gradient in boron-doped graphite to achieve maximum p-type thermoelectric output was established. The production of an n-type silicon carbide–graphite composit was studied. Theoretical studies produced a detailed picture of the effect of doping on the electronic properties of graphite. A method was developed for the preparation of rare earth nitrides in a good state of purity. Electrical studies of the materials produced showed that several of the compounds are semiconductors as had been predicted. (M.C.G.)

33375 (NYO-10469) STUDY OF BONDING BETWEEN UO_2 AND SEVERAL CLAD MATERIALS. Final Report. (Westinghouse Electric Corp., Cheswick, Penna.). Aug. 13, 1962. Contract AT(30-1)-2176. 23p.

Extensive bonding and chemical reaction between Zircaloy-2 and UO_2 was found in all cases at 1100 and 1250°C. This reaction was accompanied by considerable diffusion of U and O and related brittleness of the clad material. At these temperatures no reaction was noted between 304 stainless steel and UO_2 even though intimate surface contact between these materials was achieved. Mechanical bonding between UO_2 and 2S Al was achieved at 650 and 590°C. Melting and/or extreme plasticity of this metal is thought to be responsible for its adherence to the relatively porous UO_2. (auth)

33376 (ORNL-TM-338) GRAPHITE-STAINLESS STEEL COMPATIBILITY STUDIES. B. Fleischer, J. H. DeVan, and J. H. Coobs (Oak Ridge National Lab., Tenn.). Sept. 25, 1962. Contract W-7405-eng-26. 19p.

The compatibility of type 304L stainless steel in intimate contact with graphite is being studied as a function of temperature and contact pressure. This study is an outgrowth of materials compatibility problems in present and advanced gas-cooled reactors, where structural members in direct contact with graphite provide the possibility of both carburization and self-welding. Initial studies were concerned with surface reactions in the absence of gaseous contaminants under a vacuum of 10^{-6} mm Hg at 540 to 705°C. Stainless steel specimens are pretreated to provide three surface conditions: H_2-fired, preoxidized, and Cu-plated. Surface contact pressures ranged from 0 to 10,000 psi. Test results are presented which establish the lower temperature limit for significant diffusion between graphite and stainless steel at approximately 600°C. Above this temperature, diffusion between untreated or H_2-fired stainless steel surfaces was found to effect complete bonding of the two materials at contact pressures as low as 500 psi. Bonding was effectively prevented by the presence of either an oxide film or a Cu plate at temperatures up to 700°C. Where bonding occurred, diffusion rates measured for C in stainless steel were comparable with those reported for stainless steel in C-saturated Na. However, phases produced in surface reactions between graphite and stainless steel were of higher order than those reported for the Na carrier. Lack of carburization in control specimens not in contact with graphite indicated the role of the gas phase to be unimportant at impurity pressures of 10^{-6} mm Hg. (auth)

33377 (PAN-319/I-B) INFLUENCE OF CHEMICAL TREATMENT AND NEUTRON IRRADIATION ON THE SURFACE RECOMBINATION VELOCITY IN n-TYPE GERMANIUM. Jan Chroboczek, Andrzej Czachor, and Jerzy Piekoszewski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Apr. 1962. 19p.

The study of applicability of the photomagneto-electric effect for the measurements of the surface recombination velocity (S) in n-type Ge was carried out. It was shown that if thorough etching is applied, the former surface treatment has no serious effects on final values of S. The values of S for various etches were presented. It was found that the changes of S during neutron irradiation reported by other authors are not the result of concentration increase of surface recombination centers. (auth)

33378 (TID-16800) METALLIC FUELS. Frank G. Foote (Argonne National Lab., Ill.). July 18, 1962. Contract [W-31-109-eng-38]. 25p. (UAC-6670; ANL-FGF-371)

The use of metallic fuels in nuclear reactors is discussed. It was found that metallic fuels are being considered for use primarily in fast reactors. The properties of metallic uranium are described, and methods of improving them are discussed. Uranium alloys, plutonium, and thorium were also considered. The use of inert materials in alloys with fissionable materials is discussed. Metallic fuels in the liquid state are described. (M.C.G.)

33379 RECENT DEVELOPMENTS IN THE SECTOR OF NUCLEAR GRAPHITE. E. Fitzer (Siemens–Planiawerke A. G., Augsburg). Met. ital., 54: 261-71(July 1962). (In Italian)

The developments in the sector of nuclear graphite are discussed with regard to its five properties: purity, behavior to radiation, density in mass and structure, waterproofness, and compatibility. On the basis of some test results it is shown how much the neutron absorption cross section of artificial graphite depends on impurities of boron, nitrogen, and special sands and that according to some cross sections pure carbon should have σ_a for thermal neutrons of 3.5 mbarn. Graphite behavior under neutron radiation is discussed on the basis of the obtained results and of those taken from literature. There is a distinction between the damages due to radiation conditions only, such as dosage and temperatures, but which are not connected with a particular graphite grade, and others which are related to graphite grade. On the basis of these results it is possible for the reactor operator to choose the grade of graphite more qualified for a special purpose. Besides the usual grade of nuclear graphite with block density of about 1.7 g/cm^3, pieces of graphite with block density up to 2.21 g/cm^3 have been prepared. The grades of graphite and their size limits are discussed in detail. The development in waterproof graphites by the filling of pores with pure carbon has been reached with a block density of 1.95 g/cm^3 and a permeability of 10^{-6} cm^2 sec^{-1}. The fact that non-absorbent graphite all the same can soak a certain quantity of liquid is put in evidence. The possibilities of graphite basic reactions towards other elements are reported. The behavior of graphite towards sodium and oxygen and carbon dioxide which is important for the operator of the reactor is discussed in detail. Some examples concerning different modes of application of nuclear graphite are given. (auth)

33380 URANIUM GRAIN REFINING AND STABILIZATION BY THERMAL TREATMENT ON LOW CONTENT U-Nb–Cr ALLOY. J. J. Huet and H. Massaux (Centre Nucleaire Belge, Mol, Belg.). Met. ital., 54: 277-82(July 1962). (In Italian)

In order to produce a high-content U alloy, thermal treatments were carried out on low-content Cr and Nb

alloys with variable compositions. After an adequate thermal treatment, a U alloy containing 500 ppm Cr and 500 ppm Nb gives a very fine grain which is particularly thermally stable. (D.L.C.)

33381 RECENT PROGRESSES IN THE TREATMENT AND USE OF URANIUM DIOXIDE AS NUCLEAR FUEL. R. Colombo (Fiat. Sezione Energia Nucleare, Turin). Met. ital., 54: 285-90(July 1962). (In Italian)

At present, uranium dioxide is one among the most important materials in use for the production of power nuclear reactors fuels. After a review of the experiences in Italy and other countries, dioxide carbon preparation, sintering, compaction, peening and the escape of fission gases are considered. (auth)

33382 IMPROVEMENTS IN THE TECHNOLOGY OF SAP PRODUCTION FOR NUCLEAR APPLICATIONS. D. Gualandi and T. Jehenson. Met. ital., 54: 291-9(July 1962). (In Italian)

Investigations were carried out on the possibility of reducing H_2 contents in finished sintered aluminum products (SAP). A vacuum method was developed which reduced the H_2 contents from 50 down to 1 or 2 ppm, giving SAP with adequate hot stability and improved weldability. A method was also developed for welding SAP with hot pressure. (D.L.C.)

33383 FOR REACTOR-IRRADIATION CONTAINERS — TITANIUM AND ELECTROLYTIC IRON. Rune Hardell and Sam Nilsson (Chalmers Univ. of Tech., Goteborg). Nucleonics, 20: No. 10, 108; 110-11(Oct. 1962).

Sm-5090 Al as container material was found to require a wait of 10 min before measurements of short-lived gamma activities could be made, and even then the background was still high. A search was made for container materials with suitable mechanical and nuclear properties. An alloy ATi-24 containing 99.85% Ti was found to be suitable, and measurements can be started 30 sec after pile-out. Pure, electrolytic iron can also be used with some lead shielding. (D.L.C.)

33384 CONTROLLING THE CAKING OF SINTER WITH THE AID OF RADIOACTIVE ISOTOPES. A. V. Pugachev. Radioaktivn. Izotopy i Yadernye Izlucheniya v Nar. Khoz. SSSR, Tr. Vses. Soveshch., Riga, 1960, 3: 193-5(1961).

Results obtained with the use of counter tubes to measure the intensity of gamma rays passed through a raw charge and caked sinter were unsatisfactory. The tubes were employed under production conditions at high surrounding temperatures and strong vibrations and shocks during the operation of sintering machines. Stainless-steel ionization chambers were manufactured and tested. Various gamma-radiation sources were experimentally investigated. It was established that Cs^{137} was the most suitable source. The existing means of maintaining a constant height of the charge layer assures its sufficiently stable level and excludes an effect of changes in the height on the readings of the devices. The block-diagram of an experimental equipment controlling the caking of sinter is described. A continuous control will bring about automatic regulation of the operational speed of the sintering machine, depending on the degree of caking of the sinter; this may yield a high economical effect. (Referativnyy Zhurnal, Metallurgiya, No. 2, 1961).

33385 WERKSTOFFE DES REAKTORBAUES MIT BESONDERER BERUCKSICHTIGUNG DER METALLE. (Materials of Reactor Construction with Special Consideration of Metals.). Karl Lintner and Erich Schmid. Berlin, Springer-Verlag, 1962. 596p.

The principles of nuclear fission and reactors are reviewed. Metallography is discussed, including: lattice structure, plasticity, alloy information, mechanical engineering, tempering and hardening by means of intercalation, and corrosion and erosion. A theoretical study was made of the influence of radiation on the properties of solids. Experimental results were obtained for radiation effects on lattice structure, physical and engineering properties of metals and alloys, resistance of semiconductors, physical properties of ionic crystals and insulators, and solidity of high polymers. Studies were also made of the recovery of metals from radiation effects. Fuel materials, moderators and reflectors, control rods, coolants, and construction materials were investigated. (M.C.G.)

33386 URANIUM METALLURGY. VOLUME I. URANIUM PROCESS METALLURGY. W. D. Wilkinson (Argonne National Lab., Ill.). 1962. 769p. $18.00(New York, Interscience Publishers).

Information concerning the metallurgical processing of uranium ores and metal and on safe practice in uranium metallurgy is presented. The means used and proposed for concentrating uranium ore and for converting uranium ore to intermediate products are described. Advantages and disadvantages of each process are discussed. Other topics covered include: reduction and purification of uranium, uranium fabrication, powder metallurgy of uranium, reprocessing fuel material, and safe practice in uranium metallurgy. Listings are included of uranium minerals, thermodynamic data for uranium metallurgy and liquid-liquid extraction processes and solvents. (M.C.G.)

33387 ELECTRON MICROSCOPY. Fifth International Congress for Electron Microscopy held in Philadelphia, Pennsylvania, August 29th to September 5th 1962. Volume 1. Non-Biology. Sydney S. Breese, Jr., ed. New York, Academic Press, 1962.

Two hundred and seventy-nine papers are given in abbreviated but illustrated form. The papers are grouped into the following sections: general techniques; lattice defects; surface reactions; instrument design; radiation damage; chemical and industrial; metallurgy–nonferrous; scattering; fibers and polymers; metallurgy–ferrous; thin films; physical techniques; crystals, nucleation, and growth; phase transformations; magnetic scattering; electron diffraction; electron optics. Some of the papers are in languages other than English. Thirty-eight papers are covered by separate abstracts. One was abstracted previously in NSA. (A.G.W.)

33388 TEMPERATURE RISE OF SPECIMEN DUE TO ELECTRON IRRADIATION. M. Watanabe, T. Someya, and Y. Nagahama (Japan Electron Optics Lab. Co., Ltd., Mitaka, Tokyo). p.A-8 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

The specimen temperature was measured by using the specimen itself, consisting of two evaporated metallic films, as a thermocouple. A curve shows one example of the relation between the specimen temperature and the electron current density obtained by a thermocouple of evaporated Ag and Pd films. (A.G.W.)

33389 DISLOCATIONS IN UO_2. T. S. Noggle (Oak Ridge National Lab., Tenn.). p.B-5 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

During preparation of single crystals of UO_2 for electron microscope studies, a number of (111) crystals developed arrays of etch pits delineating slip lines and slip bands. Dislocations are frequently observed in (110) crystals which do not develop etch pits. Observations of these structures reflect immobility at room temperatures and an appreciable degree of plasticity at elevated temperatures. (A.G.W.)

33390 DIRECT OBSERVATIONS OF ETCH PITS AT DISLOCATIONS IN BERYLLIUM. Victor V. Damiano (Franklin Inst. Labs., Philadelphia). p.B-6 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

The Be crystal used in this experiment was deformed the order of 10% strain by compression at room temperature. The compression surfaces were then electrolytically polished, and etch pits were produced by sudden and brief increases in the current density. Foils were prepared from the crystal. After numerous attempts, a specimen was found which revealed both dislocations in contrast and etch pits. Numerous etch pits were examined, and in every case one or more dislocations were found to be associated with the etch pits. The density of etch pits was an order of magnitude lower than the density of dislocations observed, since junctions of dislocations rather than single dislocations appeared to be preferred etching sites. (A.G.W.)

33391 THEORETICAL INTERPRETATION OF ELECTRON MICROSCOPIC OBSERVATIONS OF RADIATION DAMAGE. Allen N. Goland (Ordnance Materials Research Office, Watertown, Mass.). p.F-1 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

The theory of energy dissipation by neutrons and charged particles in solids and the resultant formation of defects is discussed. The defects one might reasonably expect to see by transmission electron microscopy are then summarized. (A.G.W.)

33392 RADIATION EFFECTS IN PLATINUM. E. Ruedl (Euratom, Brussels), P. Delavignette, and S. Amelinckx. p.F-2 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

Annealed beaten foils of Pt were irradiated with fission fragments from U, with fast neutrons, and with α particles from boron nitride. Varying concentrations of loops and dots were observed, which seemed to suggest that loop formation in irradiated foils is dependent on the presence of nuclei either left by a previous quench or made during the irradiation itself. (A.G.W.)

33393 SOME OBSERVATIONS ON RADIATION DAMAGE IN METALS. P. B. Hirsch, R. M. J. Cotterill, and M. W. Jones (Cambridge Univ., Eng.). p.F-3 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

Electron microscope specimens of Au containing stacking-fault tetrahedra were irradiated at 20°C for various times with several different fluxes of 1-Mev α particles from a Van de Graaff generator or with 3.5-Mev α particles from a Po source. Electron micrographs showed that the tetrahedra were annihilated and that typical radiation damage in the form of black spots was produced. Cu was irradiated at ~60°C with 1.5-Mev protons in a Van de Graaff generator at high fluxes. After a 3-hr irradiation the specimens were found to contain loops a few 100 Å in diameter, many of which appear to lie on planes close to those of the (111) type. The nature of the loops is being determined. (A.G.W.)

33394 THE EFFECT OF RADIATION-PRODUCED PRISMATIC DISLOCATIONS ON GLIDE DISLOCATIONS IN COPPER. I. G. Greenfield (Franklin Inst. Labs., Philadelphia). p.F-4 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

In order to study the influence of prismatic dislocations produced by neutron bombardment on the movement of glide dislocations resulting from plastic deformation in Cu, electron microscope observations were made of (1) glide dislocations initiated in thin foils and (2) glide dislocations produced in deformed bulk Cu thinned to electron transparency. Observations indicate that glide dislocations move through a field of radiation-produced prismatic dislocations, react with those prismatic dislocations, and form tight spirals and kinks. If the stress is great enough, the kinked dislocations will move through the lattice. (A.G.W.)

33395 NEUTRON IRRADIATION DAMAGE IN PURE IRON. B. L. Eyre and G. K. Williamson (Central Electricity Generating Board, Glos., Eng.). p.F-6 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

Annealed Fe foils 75μ thick were irradiated at 60°C to doses of 5×10^{17}, 5×10^{18}, and 5×10^{19} nvt. Direct evidence of irradiation damage was not observed in the two lower dose foils but was seen in the highest dose foil. Dislocation movement was studied in an attempt to throw light on observed changes in mechanical properties. Before irradiation the dislocation movement in the microscope exhibited sharp changes in slip plane (cross slip). After a dose of 5×10^{17} the scale of the cross slip was reduced and there was some evidence for the pinning of dislocations. After 5×10^{18} the pinning of dislocations could be seen in a sample deformed before examination, and in some areas trails of loops had been left behind. After a dose of 5×10^{19} the slip lines became much straighter and coarser. The dislocations became much more tangled, movement was more restricted, and the clusters became more sharply defined and grew in size. (A.G.W.)

33396 LATTICE DEFECTS INTRODUCED INTO GRAPHITE BY NEUTRON IRRADIATION. W. Bollmann (Battelle Memorial Inst., Geneva). p.F-7 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

Observations on a graphite foil stripped from a natural Madagascar flake which had been irradiated to 5×10^{19} n/cm^2 are described. The defects visible are interpreted as displacement spikes produced by secondary impacts of the ionized C atom knocked out of the lattice by a high energy neutron. Two possible types of spikes are considered: (a) collapsed spikes emptied by the impact and (b) expanded spikes produced by a local evaporation of the material within the spike and instantaneous recondensation in the amorphous state. It is concluded that expanded spikes are produced by the neutron bombardment. (A.G.W.)

33397 ELECTRON MICROSCOPE STUDIES OF RADIATION DAMAGE IN GRAPHITE. C. Baker and A. Kelly (Cambridge Univ., Eng.). p.F-8 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

Natural single crystals of graphite were examined after various irradiation and annealing treatments. Irradiation to 1.3×10^{17} n/cm^2 produced no lattice defects observable by transmission electron microscopy. Crystals irradiated to 4×10^{19} n/cm^2 at less than 200°C exhibited a 2.9% increase in the x-ray lattice parameter in the C direction and a 0.27% decrease in the a direction. Changes observed when these crystals were annealed at temperatures from 600°C to 2000°C are described. A possible explanation of the effects observed is offered. (A.G.W.)

33398 PROBLEMS IN THE ELECTRON-MICROSCOPY OF IRRADIATED GRAPHITE. P. A. Thrower and W. N. Reynolds (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.F-9 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

Three methods of estimating the thickness of graphite specimens are described. Vacancy and interstitial loops in graphite single crystals are discussed. It is suggested that interstitial loops have Burgers vectors identical to those of

vacancy loops except in sign as is the case in close-packed metals. (A.G.W.)

33399 RADIATION DAMAGE IN MgO. G. W. Groves (Cambridge Univ., Eng.). p.F-10 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

MgO single crystals were irradiated with x rays, electrons, and neutrons. X rays and electrons produced no change in the microstructure or mechanical properties. Neutron irradiation to 4.3×10^{17} nvt produced no microstructure change, but reduced the slip band length to a third its normal value. A dose of 4×10^{19} nvt produced an increase of about 10% in microhardness and a reduction in slip band length by at least a factor of 9. A fine-scale damage structure could be seen with the electron microscope. Annealing coarsened the visible damage and eventually removed it. (A.G.W.)

33400 THE BEHAVIOUR OF VACANCY AND INTERSTITIAL LOOPS IN ALUMINIUM BOMBARDED WITH FISSION FRAGMENTS. K. H. Westmacott, A. C. Roberts, and R. S. Barnes (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.F-11 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

Al films were bombarded with fission fragments for times ranging from 30 sec (5×10^{11} fission fragments/cm^2) to 32 hr (1.9×10^{15} fission fragments/cm^2). Results indicate that both vacancy and interstitial loops are formed during irradiation and that they each migrate by a process involving both slip and conservative climb. (A.G.W.)

33401 INTERSTITIAL DAMAGE IN f.c.c. METALS BY LOW ENERGY ARGON ION BOMBARDMENT. Piers Bowden and D. G. Brandon (Cambridge Univ., Eng.). p.G-1 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

An electron microscope study was made of damage produced in Au films by bombardment normal to the surface with low-energy Ar ions. Results indicate that the damage is concentrated near the bombarded surface, that compressive stresses are produced in this surface, and that the damage is interstitial. Bombardment of Au foils at −20°C and +30°C showed a critical dependence of the arrangement of the damage on temperature in this range. (A.G.W.)

33402 THE DECOMPOSITION OF CRYSTALS OF ALKALI HALIDES IN THE BEAM OF AN ELECTRON MICROSCOPE. G. A. Bassett, A. J. Forty, and M. R. Tubbs (Univ. of Bristol, Eng.). p.G-2 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

Freshly grown alkali halide crystals, apparently dislocation-free, were exposed to the beam of an electron microscope. After a short exposure the Bragg contours displaying the curvature of the platelets became diffuse and eventually broke up. A closer examination showed this to be due to formation of a large number of dislocation loops. The number and size of loops increased rapidly as irradiation was continued. The structural damage was followed by chemical breakdown. Appearance of the specimens under the electron microscope as irradiation proceeds is described. (A.G.W.)

33403 EFFECTS OF ION BOMBARDMENT OF LAMINAR MONOCRYSTALS. C. Sella, M. F. Sella, and J. J. Trillat (CNRS, Bellevue, France). p.G-3 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In French)

Thin, laminar single crystals of mica and pyrolytic graphite are bombarded by 4-kev Ar or air ions, at current densities of 0.05 to 0.1 ma/cm^2. The damage to the crystals is observed in an electron microscope, following bombardments of 5 to 300 sec. (T.F.H.)

33404 INVESTIGATIONS OF CHARGED PARTICLE TRACKS IN SOLIDS. R. M. Walker and P. B. Price. (General Electric Research Lab., Schenectady, N. Y.). p.G-4 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

Mica was irradiated with U^{235} fission fragments, oxygen nuclei, α particles, and protons. Results showed that only nuclei with masses $\gtrsim 30$ produce tracks visible under an electron microscope. This indicates that high doses of light particles can be used to produce nuclear reactions involving visible heavy fragments without the light particles contributing background. Nuclear reactions using both 3-Bev protons and 150-Mev oxygen nuclei as bombarding particles were observed. The possibility of observing "fossil" tracks produced by natural radiation processes is suggested. (A.G.W.)

33405 THE NATURE OF FISSION FRAGMENT TRACKS IN URANIUM DIOXIDE. A. D. Whapham and M. J. Makin (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.G-5 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (AERE-R-4066) (In English)

Fission fragment tracks observed in single crystal sheets of UO_2 were quite different from evaporated furrows observed in vacuum deposited films of UO_2 with a grain size of ~30Å. The type of track formed seemed to depend upon the grain size of the material. Examination of films of various grain sizes by electron microscopy showed that only a few indistinct tracks are visible when the grain size is 100Å, and no tracks can be seen in material with 150Å grains. A possible explanation of the grain size effect is offered. (A.G.W.)

33406 ELECTRON MICROSCOPY OF THE EFFECTS OF THE PASSAGE OF ENERGETIC PARTICLES THROUGH SOLIDS. J. J. Kelsch (Brookhaven National Lab., Upton, N. Y.), O. F. Kammerer, and A. N. Goland. p.G-6 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (BNL-6155) (In English)

Metal films prepared by each of three methods were bombarded by U^{235} fission fragments in the BNL reactor. Results are summarized for Al, Pt, and Li^6F. It is tentatively concluded that the mechanism mainly responsible for the damage is that of the thermal spike. (A.G.W.)

33407 FISSION FRAGMENT DAMAGE IN SEVERAL METALS AND ALLOYS. P. R. B. Higgins, K. H. Westmacott, and A. C. Roberts (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.G-7 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

Super-pure Al, 99.9% Mo, a 0.1% C ferritic steel, a 20% Ni 20% Cr austenitic steel, and spectrographically pure Cu and Ni were bombarded with fission fragments at dose rates of 1.2×10^8 to 1.6×10^{10}/cm^2/sec. Damage observed in each material is described. It is concluded that the variation in the observations in these materials may be due to the differences in the defect cluster mobility at the irradiation temperature. (A.G.W.)

33408 FISSION FRAGMENT DAMAGE IN LiF SURFACES. T. G. Knorr (Battelle Memorial Inst., Columbus, Ohio). p.G-8 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

Fission fragment damage observed in an electron microscope on (100) cleavage faces of LiF crystals was in the form of round mounds on top of the crystal surface with diameters ranging from ~0.05μ to over 1μ. There was evidence that surface migration was important in the formation of the damage structures. (A.G.W.)

33409 THE RADIATION DAMAGE OF CRYSTAL LATTICES: FISSION FRAGMENTS. Lewis T. Chadderton (Cavendish Lab., Cambridge, Eng.). p.G-9 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

Crystal specimens of several materials were prepared for examination in the electron microscope, placed against natural U foil, and irradiated with thermal neutrons for varying periods of time. Observations on platinum phthalocyanine ($C_{32}H_{16}N_8Pt$), MoO_3, MoS_2, and PbI_2 are described. (A.G.W.)

33410 SWELLING URANIUM—QUANTITATIVE METALLOGRAPHY. T. K. Bierlein, R. D. Leggett, B. Mastel, and B. S. Kosut (General Electric Co. Richland, Wash.). p.G-10 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (HW-SA-2459) (In English)

At particular combinations of U^{235} burnup, irradiation environment, and out-of-reactor treatment, U reactor fuel increases in volume due to pore formation by the fission gases Xe and Kr. A direct metallographic procedure for estimating size, shape, and distribution of these pores is described. Observations on specimens subjected to irradiation and postirradiation annealing at temperatures from 200°C to 800°C are discussed. (A.G.W.)

33411 IRRADIATION STUDIES ON CLEAVAGE PLANES OF ALKALI HALIDES AND ALKALI AZIDES. Johann A. Joebstl (USAERDL, Fort Belvoir, Va.). p.G-11 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

Single crystals of KCl, NaCl, KI, NaN_3, and KN_3 were irradiated with x rays and ultraviolet light in air and in vacuo for various times from 10 min to 5 hr. The growth of small crystallites on the irradiated surfaces is described. Observations indicate that the majority of effects observed during irradiation of alkali halides in air is due to interaction of the activated crystal surface with the atmosphere. Alkali azides undergo photolytic decomposition during irradiation. Surface changes produced by irradiation in vacuo were small. (A.G.W.)

33412 AN ELECTRON MICROSCOPE STUDY OF THE MICROSTRUCTURAL CHANGES PRODUCED IN URANIUM OXIDES DURING NEUTRON IRRADIATION AT HIGH HEAT RATINGS. B. T. Bardbury, B. J. England, and J. W. Myles (United Kingdom Atomic Energy Authority, Didcot, Berks, Eng.). p.G-12 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

A two-stage Bexfilm-carbon-AuPd shadowed replica technique was used to study uranium oxides irradiated over the range 0.25–6% burnup. An effect not previously observed was noted in grain interiors. It is thought to represent a fine scale of bubble formation due to fission gas nucleation. The bubbles were ~400Å in diameter, at an average density of $\sim 10^{15}$/cc, and often occurred in clusters or along lines in groups of three or four. (A.G.W.)

33413 REFLECTION MICROSCOPY OF IRRADIATED UO_2 CRYSTALS. J. Leland Daniel, Jr. (General Electric Co., Richland, Wash.). p.G-13 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

Irradiated and unirradiated ceramic nuclear fuels, principally UO_2, were studied by reflection electron microscopy under temperature conditions approaching those prevailing in a reactor. Fracture surfaces and polished and etched surfaces as a basis for observations are discussed. Irradiated UO_2 developed additional surface crystallites and a line or shallow crack during heating to 980°C. (A.G.W.)

33414 MICROSTRUCTURAL CHANGES ASSOCIATED WITH IRRADIATION BURNUP OF URANIUM DIOXIDE. Thomas R. Padden and Paul S. Schnizler (Westinghouse Electric Corp., Pittsburgh). p.G-14 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

Irradiated UO_2 samples with burnups from 3.5×10^{20} to 31.3×10^{20} fissions/cc and irradiation temperatures of 1940°F or less were examined by light and electron microscopy. The most important observations were that (1) there was subdivision of the grains in the higher end of this burnup range and (2) there was a concentration or precipitate of chemically reactive material, presumed to be fission products, in the grain boundaries at the lower burnup and in the subgrain boundaries at the higher burnups. (A.G.W.)

33415 PRELIMINARY OBSERVATIONS ON THE SINTERING OF BeO. J. S. Kahn and Willa Wadleigh (Univ. of California, Livermore). p.H-4 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (UCRL-6896) (In English)

Powdered BeO was mixed with a lubricant and extruded under pressure through a die. After extrusion the lubricant was burned out of the tube. Observations on the growth of BeO after sintering at 1500°C and 1600°C are described. It is suggested that at least two different growth-rate-determining mechanisms must be involved. (A.G.W.)

33416 STUDY OF PYROLYTIC GRAPHITE OXIDATION. J. J. Trillat, C. Sella, and M. Miloche (CNRS, Bellevue, France). p.I-7 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In French)

The oxidation of pyrolytic graphite cleaved along the (0001) planes is studied in air at 600°C and in CO_2 at 825°C. The oxidation processes are observed electron-microscopically. (T.F.H.)

33417 OBSERVATIONS ON STRUCTURAL ASPECTS OF GRAPHITE OXIDATION. I. M. Dawson and E. A. C. Follett (Glasgow Univ.). p.I-8 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

An ultrasonic disintegration method was used to prepare graphite specimens for electron microscopy. The method gave exceptionally clean specimens that still showed large areas of interlinked crystallite arrays. One specimen was oxidized 5 min in air at 500°C. The general surface was not attacked, but pits in the size range 90–400 Å developed. Another specimen was taken from a block of synthetic graphite irradiated to 8×10^{19} nvt. After oxidation in air for 13 min at 440°C, this specimen showed uniform etch pits roughly 300 Å in diameter over the entire surface of the individual crystallites. (A.G.W.)

33418 THERMAL OXIDATION IN NATURAL GRAPHITE. A. E. B. Presland and J. A. Hedley (C. A. Parsons Nuclear Lab., Fossway, Eng.). p.I-10 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

Thin cleavage flakes of natural Madagascar flake graphite were oxidized in air, O_2, and CO_2 and examined by transmission electron microscopy. The catalytic action of impurity particles was found to be the most important factor in the oxidation process. The following conclusions were reached: (1) thermal oxidation of natural graphite, catalyzed or not, takes place predominantly at the edge of the basal plane; (2) catalysis by Cu, Ni, Fe, and Pt takes place at the metal-graphite interface and leads to the formation of channels; (3) these channels tend to lie in $(11\bar{2}0)$ directions; (4) there is no preferred crystallo-

graphic direction in the basal plane for noncatalyzed attack. (A.G.W.)

33419 AN ELECTRON MICROSCOPE STUDY OF QUENCHED GRAPHITE. C. Baker (Cambridge Univ., Eng.). p.I-11 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

Graphite single crystals quenched from above 3000°C and annealed at temperatures above 1000°C contain circular loops of dislocation. The nature of the loops is discussed. Two values of the activation energy for self-diffusion in graphite are estimated by different methods. Both are consistent with a vacancy mechanism of self-diffusion. (A.G.W.)

33420 THE EFFECT OF IMPURITY ON THE DISLOCATION ARRANGEMENT IN DEFORMED POLYCRYSTALLINE ZIRCONIUM. J. E. Bailey (Berkeley Nuclear Labs., Glos., Eng.). p.J-4 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

Specimens of Ar arc melted crystal bar Zr and commercial Zr were deformed in tension and examined in an electron microscope. In the commercial Zr, which contained oxygen and nitrogen, the dislocations appeared as straight lines. The pure crystal bar Zr showed complex tangles of dislocations. It was concluded that the presence of oxygen and nitrogen radically alters the type of dislocation arrangement observed in Zr, and that the greater hardness of the commercial Zr must be associated with the apparently restricted dislocation movement. (A.G.W.)

33421 ELECTRON MICROSCOPE STUDIES OF PRECIPITATION IN THE ZIRCONIUM HYDROGEN SYSTEM. J. E. Bailey (Berkeley Nuclear Labs., Glos., Eng.). p.K-9 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

Zr air-cooled from 770°C in H_2 and containing about 0.1 at. % H_2 was examined in an electron microscope. The small precipitates previously observed in Zr were seen, and in addition the same specimen showed quite large precipitates. Hydride precipitates intermediate in size between these were formed by various annealing treatments and by quenching Zr from 800°C into iced brine. Characteristics and possible identity of the precipitates are discussed. (A.G.W.)

33422 PRECIPITATION OF NIOBIUM AND CHROMIUM CARBIDES AT THE GRAIN BOUNDARIES OF AN 18Cr/12Ni/1Nb AUSTENITIC STEEL. R. N. Younger, D. M. Haddrill, and R. G. Baker (British Welding Research Assn., Abington, Cambridge, Eng.). p.CC-3 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

Specimens of an 18Cr/12Ni/1Nb steel were given a rapid thermal cycle with a peak temperature of 1350°C and aged for 10 hr at 650°C. A typical micrograph shows a leafy dendritic precipitate of NbC and a dense precipitate of $M_{23}C_6$ nucleated on the NbC leaves. Similar specimens were solution treated for 3 min at 1300°C and aged at 650°C. On aging very thin leafy precipitates formed at the boundaries and subsequently chromium carbide nucleated on these. (A.G.W.)

33423 THE EFFECT OF HEAT TREATMENT ON THE PRECIPITATION OF NbC IN AUSTENITIC CREEP RESISTING STEELS. F. B. Pickering, K. W. Burns, and S. R. Keown (The United Steel Companies, Ltd., Moorgate, Rotherham, Eng.). p.CC-4 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

The solution of NbC in austenitic steels increases with increasing solution treatment temperature and with increasing time at any given temperature until equilibrium is reached. Up to a solution treatment temperature of 1200°C, subsequent precipitation of NbC during aging at 650–900°C occurs only on dislocations. With solution treatment temperatures above 1200°C, precipitation during subsequent aging occurs first on dislocations but later also on stacking faults. The mechanism of formation of the stacking faults is discussed. (A.G.W.)

33424 EFFECT OF A SMALL ADDITION OF NIOBIUM ON PRECIPITATION IN A Fe–0.03% C ALLOY. P. Gielen and T. Greday (CNRM, Liege). p.CC-5 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In French)

Foils of Fe–0.03% C and Fe–0.03% C–0.04% Nb are subjected to various treatments at 100 to 950°C. It is observed that in some of the Fe–C–Nb samples several types of dislocations may occur, and that under some conditions these dislocations may be surrounded by clusters of particles that are precipitated from the alloy. The composition of these precipitates is discussed. (T.F.H.)

33425 EFFECTS OF ELECTRON BOMBARDMENT ON ALKALI HALIDE SINGLE CRYSTAL SURFACES. A. K. Green, G. Turner, and E. Bauer (Michelson Lab., China Lake, Calif.). p.GG-6 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962. (In English)

Current density, specimen temperature, and bombardment time were varied during electron bombardment studies of alkali halide surfaces. Increasing surface roughness was noted with increasing current density. At temperatures below 175°C surface roughness was seen, but at 215°C etch pits were found within the bombarded area. The etch pits became larger at higher specimen temperatures. The effect of total bombardment time was least noticeable of all the parameters. Evidence was seen that the electron beam directly or indirectly dissociated the alkali halide crystal and that strong recondensation occurs adjacent to the bombarded area. (A.G.W.)

33426 PLUTONIUM ALLOYS CONTAINING CONTROLLED AMOUNTS OF PLUTONIUM ALLOTROPES OBTAINED BY APPLICATION OF HIGH PRESSURES. Reed O. Elliott and Karl A. Gschneidner, Jr. U. S. Patent 3,043,727. July 10, 1962.

A method is given for making stabilized plutonium alloys which are free of voids and cracks and have a controlled amount of plutonium allotropes. The steps include adding at least 4.5 at. % of hafnium, indium, or erbium to the melted plutonium metal, homogenizing the resulting alloy at a temperature of 450°C, cooling to room temperature, and subjecting the alloy to a pressure which produces a rapid increase in density with a negligible increase in pressure. The pressure required to cause this rapid change in density or transformation ranges from about 800 to 2400 atmospheres and is dependent on the alloying element. (AEC)

Corrosion

33427 (AAEC/E-88) REACTIONS OF PREOXIDISED BERYLLIUM POWDER IN MOIST CARBON DIOXIDE. R. B. Adams, G. H. Price, and W. I. Stuart (Australia, Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). June 1962. 13p.

Breakaway corrosion of Be in moist CO_2 can be avoided if the Be is fabricated using preoxidized powder. The powder is preoxidized by heating in dry O_2. Preoxidation of Be powder was measured as a function of temperature and time of heating in O_2. The subsequent reactions of the preoxidized powder in moist CO_2 at 700°C were studied and

the effect of increasing amounts of added oxide was measured. A model is proposed to explain the inhibition of corrosion by added oxide. (auth)

33428 (CRGM-1103) METALLOGRAPHIC EXAMINATION OF ZIRCALOY-2 SHEATHED URANIUM DIOXIDE FUEL ELEMENTS IRRADIATED AT HIGH HEAT RATINGS. G. W. Parry (Atomic Energy of Canada Ltd., Chalk River, Ont.). June 1962. 24p. (EXP-NRX-21104; AECL-1592)

Results of metallographic examination of a failed Zircaloy-2 clad UO_2 fuel element are discussed. The specimen failed after 16.2 effective full power days of reactor irradiation. The heavy hydriding which was observed in the Zircaloy was ascribed to reactions with water. Appreciable interaction occurred between the UO_2 and Zircaloy-2. Oxidation of UO_2 by steam to U_4O_9 was observed. (J.R.D.)

33429 (DP-779) STRESS-CORROSION CRACKING OF 17-4 PH STAINLESS STEEL. Raymond P. Jackson (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Sept. 1962. Contract AT(07-2)-1. 7p.

Exposure of 17-4 PH stainless steel to a simulated HWCTR environment indicates that this alloy is susceptible to stress-corrosion cracking when aged at 900°F, but is not susceptible when aged at 1100°F. (auth)

33430 (EURAEC-318) MICROGRAVIMETRIC INVESTIGATION INTO THE MECHANISMS OF CORROSION OF REACTOR MATERIALS IN THE PRESENCE OF NUCLEAR RADIATION. Quarterly Report No. 1, January 1 to March 31, 1962. (Battelle Institut e. V., Frankfurt am Main). Work Performed under United States–Euratom Joint Research and Development Program. Contract 071-62-1-RDD. 32p.

The design of the apparatus for the gravimetric determination of corrosion effects was completed. The construction of the apparatus is under way. Integral parts of the unit include a vertical stainless steel tube with a guide bar in the center for moving the β-source (Y^{90}–Sr^{90}) arranged in rotational symmetry up and down. The upper part of the tube extends into a larger chamber where six electronic microbalances are arranged in such a manner that the specimens suspended from them are free to move between the tube wall and the radiation source. By means of a high-vacuum pumping system (turbomolecular pump, diffusion pump, rotary pump) the apparatus can be evacuated to about 10^{-4} mm Hg. The corrosive gases are mixed in a separate apparatus and slowly passed through the apparatus during the experiment. In its position of rest the radiation source is located at the bottom of the tube and shielded on top by a stainless steel block. During the experiment, the source is lifted together with the block until it has reached the level of the specimens. The tube is provided with a shield against the bremsstrahlung encountered upon impingement of the β-rays on the specimens and on the wall. Both tube and shield may either be electrically heated up to temperatures of approximately 300°C, or cooled by liquefied O_2 to −196°C. (auth)

33431 (TID-16833) CORROSION OF NUCLEAR METALS AND CORROSION OF NUCLEAR AND OTHER METALS. Final Report. M. E. Straumanis and W. J. James (Missouri. Univ., Rolla. School of Mines and Metallurgy). June 1962. Contracts AT(11-1)-73 and AT(11-1)-1047. 42p.

Studies were made of the rates of dissolution of Ti, Zr, Hf, Be, and Mg and the solid solutions TiO_x, ZrO_x, HfO_x, TiN_y, and TiO_xN_y in various mineral acids, particularly in Hf. The mechanism of corrosion and other electrochemical phenomena was investigated. (M.C.G.)

33432 (WADD-TR-61-123(Pt.II)) PROPERTIES OF YTTRIUM AND THE RARE EARTH METALS, EFFECT OF MINOR ADDITIONS TO NIOBIUM-BASE ALLOY ON ELEVATED TEMPERATURE OXIDATION RESISTANCE. Craig G. Kirkpatrick (Research Chemicals. Div. of Nuclear Corp. of America, Phoenix, Ariz.). June 1962. Contract AF 33(616)-6829. 117p.

Approximately 180 compositions in 19 Nb based alloy types were prepared for study. Atmospheric corrosion tests were completed for 9 series of alloys. Improved corrosion resistance is indicated for a Nb alloy containing 7% Ti, 20% W, and 3% Mo when rare earth metals are added. Possible improvement, on the addition of rare earths, is also suggested for a Nb alloy containing 11.3% Ti and 7.9% Mo. Metallurgical investigations of two alloy series failed to indicate correlation between metal interface movement or microhardness values with corrosion resistance as established by weight gain measurements. (auth)

33433 (WAPD-TM-307) THE EFFECT OF LITHIUM HYDROXIDE AND RELATED SOLUTIONS ON THE CORROSION RATE OF ZIRCALOY IN 680 F WATER. E. Hillner and J. N. Chirigos (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Aug. 1962. Contract AT(11-1)-Gen-14. 42p.

Experiments were conducted on the corrosion and hydrogen absorption characteristics of Zircaloy-2, nickel-free Zircaloy-2, and Zircaloy-4 in 680°F lithium hydroxide, potassium hydroxide, and lithium salt solutions. No adverse effects of lithium hydroxide on either the corrosion or hydrogen absorption kinetics in solutions up to and including 2×10^{-3} molar (pH ~ 11.3) was uncovered; with more concentrated lithiated solutions (5×10^{-3} molar and above) a severe loss of corrosion resistance was clearly indicated. Hydrogen absorption data were found to be consistent with neutral water exposure over the range of concentrations studied. (auth)

33434 (AEC-tr-5382) EXAMINATION APPARATUS FOR THE CAVITATION TEST IN LIQUID METALS. CORROSION OF IRON AND STEEL IN LIQUID METALS. Yunoshin Imai, Yoshimitsu Kikuchi, and Tetsuro Isizaki. Translated for Oak Ridge National Lab., Tenn., from Nippon Genshiryoku Gakkaishi, 4: 77-84(Feb. 1962). 24p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, as abstract no. 13537.

33435 (AEC-tr-5405) SOME ASPECTS OF THE THEORY OF CORROSION OF REACTOR MATERIALS IN CRITICAL-PARAMETER WATER. (Nekotorye Voprosy Teorii Korrozii Reaktornykh Materialov v Vode Kriticheskikh Parametrov). V. V. Gerasimov, A. I. Gromova, and G. S. Moskvichev. Translated from IAEA Preprint No. CN-13/51 presented at the Conference on Corrosion of Reactor Materials, Salzburg, June 4-9, 1962. 16p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, as abstract no. 22562.

33436 (AEC-tr-5408) MECHANISM OF CARBON TRANSFER IN LIQUID SODIUM. (Mekhanizm Perenosa Ugleroda v Zhidkom Natrii). V. S. Lyashenko and B. A. Nevzorov. Translated from IAEA Preprint No. CN-13/41 presented at the Conference on Corrosion of Reactor Materials, Salzburg, June 4-9, 1962. 33p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, as abstract no. 22160.

33437 (AEC-tr-5409) RESISTANCE TO CORROSION OF AUSTENITIC AND FERRITO-PEARLITIC STEELS IN

A STREAM OF LIQUID SODIUM AT TEMPERATURES OF 600 AND 700°C. (Korrozionnaya Stoikost Austenitnykh i Ferritoperlitnykh Stalei v Potoke Zhidkogo Natriya pri Temperaturakh 600 i 700°C). V. S. Lyashenko, V. V. Zotov, and V. A. Ivanov. Translated from IAEA Preprint No. CN-13/50 presented at the Conference on Corrosion of Reactor Materials, Salzburg, June 4-9, 1962. 19p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, as abstract no. 22561.

33438 THE CORROSIVE ACTION OF ZIRCONIUM TETRAFLUORIDE VAPORS ON STEEL NO. 1Kh18N9T AND ON NICKEL AT ELEVATED TEMPERATURES. V. I. Tsirel'nikov, L. N. Komissarova, and Vikt. I. Spitsyn. At. Energ. (USSR), 13: 51-3(July 1962). (In Russian)

For the separation of Zr from Hf, it was found convenient to make use of the chlorides of these elements. For this reason, it is important to determine the corrosive action of ZrF_4 vapors, containing HfF_4 in the natural ratio, on various structural metals; therefore the resistance of a Cr-Ni-Ti stainless steel and of Ni against attack by ZrF_4 at high temperature was investigated. The corrosion rate was calculated from the weight changes of specimens heated in a closed ampoule containing a known amount of ZrF_4 until the desired pressure was reached; tests were also by exposing the specimens to a stream of ZrF_4 at the desired temperature. The corrosion rate was found to increase with increasing temperature: it changed very little in the 350 to 450°C range, being within 0.35 to 0.42 g/m^2 hr while at 830°C the specimen was completely consumed in 20 hours. The corrosion was found to be a uniform process, following the straight-line law. Increase of the pressure also resulted in a considerable increase of the rate. At the same temperature Ni was found to be more resistant than steel; its rate followed the logarithmic law as the result of the formation of a protective layer on the surface. (TTT)

33439 CORROSION OF CARBON STEEL AND OTHER STEELS IN SIMULATED BOILING-WATER REACTOR ENVIRONMENT: PHASE II. D. C. Vreeland (U. S. Steel Corp., Monroeville, Penna.), G. G. Gaul, and W. L. Pearl. Corrosion, 18: 368t-77t(Oct. 1962).

Results are reported for the continuation of extensive corrosion testing of carbon and other steels exposed in a dynamic test loop simulating the various environments found in a nuclear boiling-water reactor system. Water and steam conditions were based on 10 to 20 ppm oxygen and 1 to 2 ppm hydrogen in the 546°F saturated steam, a condition representative of the radiolytic water decomposition in boiling-water reactors. The pH of the high-purity water was about 7, and no chemical additives were used in the loop water. Tests were conducted to determine (1) whether stress-corrosion cracking would occur and (2) the effect of simulated reactor startup and shutdown on corrosion, including pitting, rusting, and local attack. The results of the investigation show that: (a) There was little, if any, difference in corrosion among the various steels tested containing up to 5 percent chromium. (b) Stress-corrosion cracking was not detected in steels containing up to 5 percent chromium or in austenitic and ferritic stainless steels. (c) Stress-corrosion cracking was detected in one specimen of hardened AISI Type 431 martensitic steel tested in steam-water environment. (d) Pitting, rusting, and local attack of steels containing up to 5 percent chromium can occur in reactor-grade water during simulated reactor shutdowns when the water is at or near room temperature and has access to air. (auth)

33440 CORROSION STABILITY AND ELECTROCHEMICAL PROPERTIES OF Zr AND Ti AND Ti-Zr ALLOYS IN SULFURIC ACID. V. V. Andreeva and A. I. Glukhova. Zh. Prikl. Khim., 35: 1771-7(Aug. 1962). (In Russian)

Electrochemical and corrosion behavior of Zr-Ti alloys in sulfuric acid solutions at 40, 60, and 100°C was analyzed. The corrosion resistance of Zr-Ti alloys becomes low in 80% sulfuric acid due to the low stability of Zr. Additions of Zr^{+4} slow or inhibit the rate of Zr corrosion depending on the amount of admixture, concentration, and temperature of the sulfuric acid solution. (R.V.J.)

33441 CORROSION AND ELECTROCHEMICAL BEHAVIOR OF Zr, Ti AND Zr-Ti ALLOYS IN PHOSPHORIC AND NITRIC ACIDS. A. N. Glukhova and V. V. Andreeva (Inst. of Physical Chemistry, Academy of Sciences, USSR). Zh. Prikl. Khim., 35: 1778-86(Aug. 1962). (In Russian)

A high Zr corrosion stability was observed in 40% phosphoric acid solutions at 100°C, while Ti was found to be stable in up to 88% phosphoric acid at 20°C and up to 20% acid at 40°C. Zr-Ti alloys are considerately stable in 60% acid at 40°C. Both Zr and Ti have a high corrosion resistance in nitric acid, however, at increased acid concentrations and temperatures zirconium resistance is about 10 folds higher than titanium. Zirconium and titanium are both subject to anodizing in phosphoric and nitric acids. The film on Zr reaches 1.5 to 3 μ following 3-hour anodic oxidation at a potential of +1.35 v. (R.V.J.)

33442 CORROSION OF ALUMINUM-CLAD FUEL ELEMENTS. D. R. Dickinson, R. J. Lobsinger, and R. B. Richman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 24, 1962. Contract AT (45-1)-1350. 19p. (HW-SA-2661)

To be published in TID-7642, Proceedings of the Symposium on Research Reactor Fuel Element, Gatlinburg, Tenn., Sept. 17-19, 1962.

The corrosion rates of aluminum-clad fuel elements measured in in-reactor pressurized-water loops were found to be considerably greater than the rates measured in ex-reactor tests at the same temperature at the water-oxide surface. It is not possible to express the corrosion rate to be expected on aluminum fuel cladding as any simple function of temperature and water quality. Three other factors were found to be significant in aluminum corrosion which result in higher rates for fuel elements: dissolution, heat transfer, and radiation. The corrosion of aluminum is promoted by the dissolution of the protective oxide. Since the water adjacent to the oxide on a fuel element is at a higher temperature than the bulk water, it cannot be kept saturated, and a fairly high dissolution rate results. Under many conditions the dissolution rate is nearly equal to the corrosion rate. Corrosion rates measured for electrically heated samples were higher than for unheated samples at the same oxide-water surface temperature. Reactor radiation was found to increase the corrosion rate of unheated aluminum samples several fold in filtered river water at low temperatures. However, it produced only moderate or no increase in deionized water at higher temperatures. An effective way to reduce the corrosion of aluminum cladding was found to be to reduce the pH of the water using phosphoric acid. In a series of in-reactor tests in which the pH was reduced to 4.5 with phosphoric acid the uniform corrosion of aluminum-clad fuel elements was not excessive. However, a heavy crud layer was deposited on the fuel elements. This led to much higher radioactivity in the external piping and components of the loop, and also raised the cladding temperature to the point where rapid intergranular attack occurred at some points. (auth)

Fabrication

33443 (ARF-2212-6) DEVELOPMENT OF DUCTILE BERYLLIUM COMPOSITES. Final Report, December 23, 1960–December 22, 1961. Frank A. Crossley and R. J. Van Thyne (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Feb. 1, 1962. Contract NOw-61-0370-c. 29p. (AD-273287)

An effort to produce ductile Be composites by liquid-phase sintering is reported. Ductility in a predominantly Be composite was sought through the attainment of a structure in which Be particles are enveloped in a ductile metallic matrix. As the result of the investigation of Al–Ag binary alloys, Al-40 to 50% Ag compositions were added to the Ag-5 to 8% Al compositions as candidate matrices satisfying the requirement that the flow stress of the matrix be matched to that of the principal phase. Composites produced for final evaluation contained defects originating from the processing schedule. The feasibility of applying liquid-phase sintering to produce Be composites was established. However, to obtain a fair evaluation of the question of ductility improvement, it is necessary to develop compacting and sintering procedures which will yield sound material for mechanical testing. (auth)

33444 (ARF-2231-6) PILOT EVALUATION OF VANADIUM ALLOYS. Bimonthly Report No. 6, July 18, 1962–September 17, 1962. B. R. Rajala and F. C. Holtz (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Oct. 15, 1962. Contract NOw 62-0101-c. 19p.

Alloys of Nb–V containing reactive and refractory metal and interstitial additions were prepared as 200-gram nonconsumable-electrode arc-melted ingots. At the 20 wt.% Nb level, strengths as high as 54,000 psi at 2000°F were measured for a V–5 wt.% Ti–20 wt.% Nb–10 wt.% Ta composition; at 60 wt.% Nb, the strongest alloy was V–1 wt.% Ti–60 wt.% Nb–2.5 wt.% Mo–0.5 wt.% Ru which had an ultimate tensile strength of 65,000 psi at 2000°F. Additions of W, Ta, or Mo generally caused reduced fabricability and ductility. Extruded bar stock and warm-rolled plate and sheet from the 100-pound consumable-electrode arc-melted ingot of V–1 wt.% Ti–60 wt.% Nb were received at the Foundation. Initial examination indicated that this material was free from defects. (auth)

33445 (BMI-1579) IMPROVED TECHNIQUES FOR DISPERSING COATED FUEL PARTICLES IN CERAMIC BODIES. Allison K. Smalley, M. Clifford Brockway, and Winston H. Duckworth (Battelle Memorial Inst., Columbus, Ohio). May 22, 1962. Contract W-7405-eng-92. 34p.

Coated fuel particles usually are oxidation resistant and retain fission products. The particles are normally dispersed within a ceramic matrix. A difficulty encountered in making dispersions is cracking of the coatings during blending and pressing. Two additional problems specific to oxide-base bodies are: interference of the dispersed particles with densification of the matrix during sintering and oxidative disruption of a body caused by progressive crack propagation through all particle coatings. These problems were solved by use of a pelletizing technique. Each coated particle is overcoated with a matrix material, either graphite or Al_2O_3. The spherical pellets are compacted and then heat treated. In oxide-base bodies, a burnout layer is incorporated into the pellet to allow room for matrix shrinkage on sintering, and to provide a void surrounding each particle. This void serves as a barrier to prevent a matrix crack from propagating into a particle coating, and also as a reservoir to contain the volume expansion associated with any oxidation of UO_2 to U_3O_8. Bodies prepared have the following characteristics: nearly ideal geometric dispersion of coated fuel particles in a dense, continuous, and strong matrix; fuel-particle coatings undamaged in processing; uniform fuel content; and surfaces free of fuel particles. (auth)

33446 (DC-60-3-173) AN INVESTIGATION OF ELECTRICAL DISCHARGE MACHINING AS APPLIED TO CORE DRILLING BERYLLIDES. R. F. Bucher (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Mar. 1960. Contract AT(11-1)-171. 37p.

Applicability of the electrical discharge machining process to core drilling zirconium beryllide ($ZrBe_{13}$) and niobium beryllide ($NbBe_{12}$) was investigated. Test series were designed to investigate the effects of the following variables on the machinability and physical characteristics of the beryllides: electrode material; current densities; electrode design; servomechanism feed rates; electrode dielectric pressures; and proximity of ground location. The process is one of three which are currently under evaluation to determine their relative applicability to the machining of beryllides. The processes under study are: electrolytic machining; diamond grinding and core drilling; and electrical discharge machining. Comparison of the free machining rates developed for beryllides with published removal rates for standard materials under similar conditions is presented. This relative comparison indicated superior removal rates for the beryllides when the electrical discharge machining process was employed. Cutting rates of 0.70 in./min for zirconium beryllide and 0.31 in./min for niobium beryllide were obtained utilizing a 0.250-OD electrode. Further decreases in cutting time per hole were anticipated through changes in electrode design, and application of gang drilling. Billet and core fracture presented a significant problem in the machining of zirconium beryllide. The incidence of this fracture, however, was lower than was observed in diamond core drilling, where pressure is exerted between the tool and work-piece. Two-to-three minutes per inch of cut must be added to the cutting time listed for zirconium beryllide, to allow for removal of pieces of fractured core, which cause interruption of cut. Effort is currently being directed in the department toward improving the ductility of zirconium beryllide. Billet and core fracture was not experienced in the tests which were run on niobium beryllide. Machinability studies were not concluded on the other two processes under study, but there was limited diamond core drilling accomplished. A comparison of the two partially developed processes indicates cutting rates two-to-three times faster when the electrical discharge machining process is employed. One metallographic report was received and no adverse effects from the process were noted; consideration should be given to the limited nature of this data however. The positive results of this investigation lead to the recommendation that continued effort, commensurate with the over-all beryllide program, be directed toward the further development of the electrical discharge process for machining beryllides. (auth)

33447 (GAT-Z-4115) DIE CASTING OF COMPRESSOR BLADES. Report No. 62-5. Final Report. G. F. Hodgson (National Lead Co. Doehler-Jarvis Div., Toledo). May 15, 1962. Contract AT(33-2)-1. 41p.

Superior die life is obtained by changing the gating from the shank end to the tip end of the blade. This occurs with some sacrifice of the mechanical properties such as shank strength and fatigue properties. Significant improvement in the mechanical properties and internal quality of blades is obtained through the use of vacuum casting and a pres-

sure pin arrangement while retaining the improved die life due to tip gating. (auth)

33448 (GEAP-4032) VIBRATIONAL COMPACTION OF URANIUM DIOXIDE. W. R. DeHollander (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Mar. 1, 1962. Contract AT(04-3)-361. 69p.

Rough, angular particles of fused uranium dioxide of mesh size ranges defined by Tyler screen sizes the square root of two apart in diameter, will pack to densities between 58–65 per cent of theoretical in tubes close to one-half inch internal diameter or smaller. Binary mixtures of 2 size ranges are capable of producing much higher densities, with one, an $^{8}/_{10}$, −200 mix, yielding 82 per cent. A 3-size range of coarse, together with 5 micron powder, went to 87.8 per cent. Ternary mixtures are easily capable of 88 per cent, and quarternary mixtures greater than 90 per cent. Segregation can be controlled and minimized by the use of noise during feeding and slight restraint during sine wave cycling. Plastic deformation is involved in packing UO_2 since mixtures above 85 per cent are removed with difficulty from their containing tubes. Powder stress is variable from lot to lot and constitutes an important variable, since the friability determines the best starting formula for a given final density. (auth)

33449 (HW-51842) DESIGN CRITERIA FOR PLUTONIUM FABRICATION PILOT PLANT — PROJECT CG-747. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 5, 1957. Contract AT(45-1)-1350. 102p.

The design concepts and requirements for a plutonium fabrication pilot plant are outlined. The design criteria are given for the pilot plant building and process equipment to be used for development work and the fabrication of reactor fuels containing plutonium. Particular emphasis is placed upon the process equipment requirements, the radiological and toxicological hazards, and the hooding concepts. (N.W.R.)

33450 (HW-73318) PLUTONIUM METALLURGY OPERATION QUARTERLY PROGRESS REPORT, JANUARY–MARCH 1962. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 16, 1962. Contract AT(45-1)-1350. 56p.

Plutonium fuels development is discussed, including: PRTR fuels, fabrication development, irradiation testing, plutonium ceramics research, and special plutonium fuel fabrications. Fabrication of physics tests standards and fission-product-transient samples is discussed. Rolling of unalloyed plutonium and plutonium alloys is described. (M.C.G.)

33451 (HW-SA-2702) HIGH INTEGRITY WELDS IN STAINLESS STEEL — TECHNIQUES, REQUIREMENTS. E. B. LaVelle (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 23, 1962. Contract AT(45-1)-1350. 14p.

Welding procedures in the fabrication of austenitic stainless steels are discussed. The joint deficiencies that must be taken into consideration are described. Preparation, cleanliness, control of materials, development of appropriate welding procedures, application of chosen techniques, supervision, and inspection are discussed. (M.C.G.)

33452 (LAMS-2736) THE APPLICATION OF ULTRAFINE PARTICLES IN TUNGSTEN POWDER METALLURGY. P. R. Mundinger, H. H. Hausner, and W. H. Lenz (Los Alamos Scientific Lab., N. Mex.). July 1962. Contract W-7405-eng-36. 13p.

Ultra-fine tungsten powder (3.7 m^2/g surface area), in amounts up to 25%, was mixed with commercial tungsten powders of 2, 4.5, and 6.8 micron average particle size. When compacted at 60 tsi, the densities varied from 69% (of theoretical) for the 2 micron admixture to 76% for the 6.8 micron admixture. Upon sintering in hydrogen for three hours at 1700°C, the corresponding values were 92% and 80%. The highest sintered densities were obtained in every case with the largest addition of ultra-fine powder. The radial/axial shrinkage ratio of the compacts was found to correlate with the density increase during sintering. This ratio (varing from 0.80 to 1.86 for all the mixtures) decreased with increasing amount of densification for each series of specimens. (auth)

33453 (NAA-SR-Memo-7283) YTTRIUM AND BERYLLIUM END PLUG BONDING. E. L. Reed (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 5, 1962. Contract [AT-11-1-GEN-8]. 24p.

The feasibility of diffusion bonding beryllium end plugs to beryllium tubing was demonstrated. Excellent bonds were accomplished after one hour at 1000°C in vacuum by using a molybdenum restraining die to develop the necessary pressure for diffusion. This process appears to be applicable to scale-up for end closure diffusion bonding of quantity batches of beryllium tubing by using a multiple cavity molybdenum restraining die. Inert-gas-shielded welding of beryllium tube and end plug assemblies was unreliable, even when attempted in an atmosphere welding glove box with a dew point of less than minus 60°F. It was possible to effect helium leak tight end closures occasionally by precise one-pass welds in the atmosphere glove box, but multiple pass welds were invariably of poor quality. Satisfactory yttrium, inert-gas-shielded arc welds were effected only after acid treatment of the surfaces to be welded, followed by vacuum outgassing at elevated temperature and welding in an argon atmosphere of minus 30°F or better. Yttrium appears to be even more sensitive to surface contamination than zirconium. (auth)

33454 (NMI-7218-1) EVALUATION OF FIFTEEN INNER TUBES OF ZIRCALOY-CLAD UNALLOYED URANIUM FOR THE HWCTR. A. B. Bremer (Nuclear Metals, Inc., Concord, Mass.). Aug. 15, 1962. Contract [AT(30-1)-1565]. 40p.

Data obtained in evaluation of 15 Zircaloy-clad unalloyed uranium inner tubes for HWCTR fuel elements coextruded with integral zirconium end seals. Results indicated that all 15 inner tubes meet the specifications with exceptions in the cases of the outside diameters. The circumferential variation of one tube's outside cladding thickness departed slightly from specification. (M.C.G.)

33455 (NP-12097) MOLYBDENUM SHEET ROLLING PROGRAM. Interim Report No. 9, September 26, 1960 to November 25, 1960. (Universal-Cyclops Steel Corp., Bridgeville, Penna.). Jan. 25, 1961. Contract NOas 59-6142-c. 59p.

During the period Mo + 0.5% Ti ingots produced by various arc melting practices were evaluated for chemical quality. Sheets produced from these ingots were evaluated for gage variations and room temperature mechanical properties. Three additional Mo + 0.5% Ti ingots were melted reproducing the melting variations. Upset testing of Mo + 0.5% Ti and TZM at high temperatures in InFab was initiated. Work is continuing on the development of an extrusion practice for large billets of TZM alloy. (auth)

33456 (NP-12119) MOLYBDENUM SHEET ROLLING PROGRAM. Interim Report No. 14, August 26, 1961 to October 25, 1961. (Universal-Cyclops Steel Corp.,

Bridgeville, Penna.). Oct. 25, 1961. Contract NOas 59-6142-c. 119p.

Both hot and cold forged molybdenum sheet bars were produced. These sheet bars were rolled to 0.060 inch sheet and tested. An over-all evaluation of Mo + 0.5% Ti sheet bar fabrication practices investigated in Phase I of the program is scheduled. A recommendation for sheet bar fabrication practice to be used in the balance of the Mo + 0.5% Ti program was made and approved. (auth)

33457 (UCRL-6725) SINTERABILITY STUDIES OF BeO COMPACTS. Raymond Cooperstein (California. Univ., Livermore. Lawrence Radiation Lab.). June 28, 1962. Contract W-7405-eng-48. 31p.

Work was carried out to determine the optimum sintering conditions for cold-pressed BeO bodies from specific commercial lots of beryllia powder. The effects of 0.1 to 0.5 wt % additions of specific oxides on the sinterability of the beryllia powders were also studied. Results indicated that high-density bodies can be fabricated from pure sulfate-derived beryllia using a cold pressing and sintering technique. Maximum densification was obtained by sintering the bodies in a hydrogen atmosphere at temperatures between 1550 and 1700°C. The effectiveness of low concentrations of minor impurities in promoting the sintering of BeO was demonstrated. Firings with most oxide additions resulted in bodies having higher densities than the pure powders. (M.C.G.)

33458 (WAL-372/32-1) DEVELOPMENT AND APPLICATION OF A THEORY FOR PLASTIC DEFORMATION OF CEMENTED ALLOYS. DUCTILE HIGH-TEMPERATURE TUNGSTEN ALLOYS. Summary Status Report, June 3, 1960–July 2, 1961. D. Weinstein and F. C. Holtz (Illinois Inst. of Tech., Chicago. Armour Research Foundation). July 28, 1961. Contract DA-11-022-505-ORD-3092. 23p.

Two-phase, "envelope-type" structures which produced ductility in previously studied W–Ni–Fe alloys were employed in the development of W-base materials having greatly increased melting points. Alloy systems based on W–Pd, W–Pt, and W–Th were prepared by liquid-phase sintering of blended and compacted elemental powders. The most promising composition W–20% Th could be cold-rolled, and had a matrix-phase melting point in excess of 2500°C. Although some porosity was present, an ultimate tensile strength of 1750 psi was measured at 2155°C. (auth)

33459 (EURAEC-232) DEVELOPMENT OF UC-BASED URANIUM CARBIDE AND CERMET FABRICATION PROCESSES. Quarterly Report No. 6, October–December 1961. (Nuklear-Chemie und-Metallurgie G.m.b.H., Wolfgang bei Hanau am Main, Germany). Work Performed under United States–Euratom Joint Research and Development Program. Contract 061-61-5-RDD. 10p. A translation.

In order to analyze uranium carbide samples for carbon values, the samples must be pulverized in a dried protective gas to obtain true values. The variations in the carbon content of the graphite–uranium dioxide mixtures used in the preparation of uranium carbide were established as a function of coarse particles in the uranium dioxide and sample size. Uranium dioxide (0.09 mm grains or larger removed) can be compacted into tablets with graphite. Tests on the reaction, $UO_2 + 3C \rightarrow UC + 2CO$, showed that uranium carbide fabricated at 1700°C reacts again with carbon monoxide at 1000°C forming 5% uranium dioxide plus graphite. Uranium carbide rods were centrifugally cast in a skull-melting furnace. The surface of the rods was improved by using fine-grained graphite molds. Improvements in the skull-melting furnace are discussed. Grinding tests on uranium carbide rods and pellets showed that the rods were tougher than the pellets. Prereacted uranium carbide pellets were fed by an automatic sorting device into a small arc-installation for continuous smelting to make bulk powder. A total of 700 g/hr can be smelted by this method. In addition to casting, uranium carbide rods were also fabricated by extruding and then reacting a uranium dioxide plus graphite mixture. Drilling tests for the fabrication of heat-conductivity samples were successfully completed. (auth)

33460 (EURAEC-315) ELECTRO-SLAG WELDING OF REACTOR STEELS. Quarterly Report No. 3, January–March 1962. (Schweisstechnische Lehr- und Versuchanstalt, Duisburg, Germany). Apr. 18, 1962. Work Performed under United States–Euratom Joint Research and Development Program. Contract 046-61-3-RDA. 10. A translation.

Welding tests were continued on 2.50 mm thick St 37 steel with different wire/powder combinations and alloy additives. Fusion tests were also made in a water-filled copper chill mold on welding wires with very low phosphorus content in order to study the influence of phosphorus contents on the impact strength after aging. In a few welding tests, discrete partial and continuous slag changes were made in order to obtain the smallest possible phosphorus and sulfur contents in the welding material. The basicity of some welding powders was increased without any detrimental effect on the quality of the weld. In some welding tests, the slag bath and welding material were protected from contact with air by applying an argon screen. (auth)

33461 (EURAEC-323) FABRICATION OF SWAGED FUEL ELEMENTS. Quarterly Report No. 7, January–March 1962. (Nuklear-Chemie und-Metallurgie G.m.b.H., Wolfgang bei Hanau am Main, Germany). Work performed under United States–Euratom Joint Research and Development Program. Contract 062-61-7-RDD. 49p. A translation.

The burn-off rate of tungsten and tungsten-zirconium electrodes in the uranium dioxide melting furnace was investigated. It was found that the angle between electrodes and the addition of argon to the hydrogen atmosphere have considerable bearing on electrode burn-off. Electron microscope photographs of uranium dioxide powders (A, AT, and S) illustrate by grain shape the increased compactness possible by swaging. The tubes used for containing the uranium dioxide fuel material consisted of 0.3 to 0.5 mm thick V2A, Zircaloy-2, and SAP materials. The ends of the tubes were plugged and flattened except for some of the V2A tubes which were provided with V2A plugs. The tubes were tested by ultrasonic methods. The vibrator used for compaction is described and diagrams show the connection between acceleration and frequency and acceleration and output. The final densities (90% theoretical) obtained by cold-swaging and annealed at 750°C between runs were no higher than with tubes that were cold-swaged without intermediate annealing and are inferior to those of comparable hot-swaged elements. The influence of wall thickness on the uranium dioxide density obtainable by swaging seem to indicate the change of density is largely independent of the wall thickness. Measurements of density, porosity, and thermal conductivity were made and metallographic examinations conducted. (auth)

33462 STUDYING THE NATURE OF METAL DEFORMATION DURING ROLLING WITH THE AID OF RADIOACTIVE ISOTOPES. O. I. Val'ter, V. A. Kostyuk.

N. P. Kologrivov, and Z. A. Yashchenko. Radioaktivn. Izotopy i Yadernye Izluchenlya v Nar. Khoz. SSSR, Tr. Vses. Soveshch., Riga, 1960, 3: 207-9(1961).

Investigations were made during the rolling of P-50 (R-50) type rail sections from an ingot weighing 9.76 tons and of a Nr.36 double Tee beam section rolled from a killed steel ingot weighing 6.75 tons. The ingots were rolled in conventional order. The nature of metal deformation in the sections was studied with the aid of the P^{32} radioactive isotope. The P^{32} isotope was introduced by separate portions and at certain intervals into the mold with the molten metal. Thus a series of zones were obtained during the crystallization process. The deformation of the zones during rolling should reflect the nature of the flow and the metal. A method was developed to study the deformation of composite rolled sections and data of practical interest for calibrating operators when developing new and corrected existing grooves were obtained. (Referativnyy Zhurnal, Metallurgiya, No. 12, 1961).

33463 WELDING OF THIN SHEET IN STAINLESS STEEL 18-8 FOR THE CANNING OF FUEL ELEMENTS. C. Bridoux and G. Fischer (Centre d'Études Nucléaires, Saclay, France). Rev. met., 59: 639-50(July-Aug. 1962). (In French)

Fuel elements consisting of uranium oxide rods are enclosed in a stainless steel can with two plugs. The can-plug assembly is produced easily and rapidly by roller welding with a semi-automatic machine. The welds thus obtained are impermeable, very strong, and easily reproducible. (auth)

33464 MULTIPLE SHAFT TOOL HEAD. H. P. Colbert (to U. S. Atomic Energy Commission). U. S. Patent 3,059,688. Oct. 23, 1962.

An improved tool head arrangement is designed for the automatic expanding of a plurality of ferruled tubes simultaneously. A plurality of output shafts of a multiple spindle drill head are driven in unison by a hydraulic motor. A plurality of tube expanders are respectively coupled to the shafts through individual power train arrangements. The axial or thrust force required for the rolling operation is provided by a double acting hydraulic cylinder having a hollow through shaft with the shaft cooperating with an internally rotatable splined shaft slidably coupled to a coupling rigidly attached to the respective output shaft of the drill head, thereby transmitting rotary motion and axial thrust simultaneously to the tube expander. A hydraulic power unit supplies power to each of the double acting cylinders through respective two-position, four-way valves, under control of respective solenoids for each of the cylinders. The solenoids are in turn selectively controlled by a tool selection control unit which in turn is controlled by signals received from a programmed, coded tape from a tape reader. The number of expanders that are extended in a rolling operation, which may be up to 42 expanders, is determined by a predetermined program of operations depending upon the arrangement of the ferruled tubes to be expanded in the tube bundle. The tape reader also supplies dimensional information to a machine tool servo control unit for imparting selected, horizontal and/or vertical movement to the tool head assembly. (AEC)

Properties and Structure

Refer also to abstracts 32635, 32636, 33105, and 34000.

33465 (ANL-FGF-360) ON THE USE OF A MODIFIED RADIAL DISTRIBUTION ANALYSIS FOR INDEXING POWDER PATTERNS. A. F. Berndt (Argonne National Lab., Ill.). June 25, 1962. Contract [W-31-109-eng-38]. 12p. (UAC-6634)

A modification of the theory of x-ray-radial-distribution analysis is presented. This modification can serve as a guide to the values of the unit cell dimensions and may be useful in indexing powder patterns of unknown structures, although the use of trial and error methods is not eliminated. This technique is shown to give consistent results with known structures and is applied to the indexing of powder patterns of Pu_3Ru and Pu_5Ru_3. The powder pattern of Pu_3Ru can be indexed on the basis of an orthorhombic unit cell with $a_0 = 6.216$ Å, $b_0 = 6.924$ Å and $c_0 = 8.093$ Å, and Pu_5Ru_3 on the basis of a tetragonal unit cell with $a_0 = 8.092$ Å and $c_0 = 10.023$ Å. (auth)

33466 (ANL-FGF-361) THE PREPARATION AND PROPERTIES OF REFRACTORY URANIUM COMPOUNDS. P. D. Shalek, G. D. White, and J. H. Handwerk (Argonne National Lab., Ill.). June 25, 1962. Contract [W-31-109-eng-38]. 17p. (UAC-6577)

Studies on preparation, sintering, and properties of UC, ThS, and US are described. (M.C.G.)

33467 (ATL-A-127) THERMAL-STRESS-FATIGUE BEHAVIOR OF ZIRCONIUM AND ZIRCONIUM ALLOYS. Final Report. K. E. Horton and R. S. Stewart (Advanced Technology Labs. Div. of American-Standard, Mountain View, Calif.). Oct. 31, 1961. Contract AT(04-3)-250. 135p.

The thermal-stress-fatigue behavior of zirconium and Zircaloy-2 was investigated under a variety of experimental conditions. The external variables taken into consideration were: temperature change, mean temperature, environment (atmosphere), and reverse loading. Material variables studied were cold work and prestraining. In addition, constant-temperature strain cycling was performed in which the following variables were examined: temperature, environment, cold working, specimen size, prestraining, and strain rate. The biggest uncertainty in thermal-stress fatigue is the amount of plastic strain in each cycle. Even in fixed-temperature strain cycling where plastic strain is more easily assessed, a general equation for fatigue life led to poor predictions at low cycles-to-failure conditions. However, a number of equations of the form $N^n\epsilon_p = K$ (N = cycles to failure, ϵ_p = plastic strain per cycle, n and K = constants) were derived and found useful for fixed operating conditions. The effect of each variable on fatigue life was illustrated. Since an appreciable number of variables were studied, the program yielded useful data which approximates many design conditions often encountered. Thus the results will be of value to anyone required to estimate, with little extrapolation, thermal-stress cycling or strain-cycling fatigue life of zirconium and Zircaloy-2. (auth)

33468 (GA-3124) INTERDIFFUSION BETWEEN URANIUM-BEARING REACTOR FUELS AND REFRACTORY-METAL THERMIONIC EMITTERS. A. Weinberg and L. Yang (General Atomic Div. General Dynamics Corp., San Diego, Calif.). May 4, 1962. Contract NAS5-1253. 17p.

Material compatibility as related to the "marriage" of reactor fuels to refractory-metal thermionic emitters is under investigation. Fuel materials such as UC, UC_2, UZrC, and UO_2 are being studied in combination with W, Mo, Ta, and Nb at 1200 to 2000°C. A technique was developed for simultaneously studying the interdiffusion between a specified U-bearing material and each of the refractory metals. UC in contact with Nb and Ta at 1875° ± 20°C and 1925° ± 30°C, respectively, reacted to form a

liquid phase identified as almost pure U metal. Mo also reacted with UC at 1800° ± 20°C, while at the same temperature W appeared relatively unaffected. However, after being in contact with UC at 2000° ± 20°C for 30 hr, W exhibited a mild reaction. The reaction mechanism for all of these metals appears to be UC + M = MC + U. Formation of this liquid phase was suppressed at 1800°C when UC-UC_2 mixtures were substituted for the UC. The kinetics of uniform metal-carbide-layer formation were studied for UC-UC_2 mixtures in contact with the refractory metals at 1800°C. In addition to the uniform carbide layers formed, severe carbide penetration of the grain boundaries was observed in Nb, Ta, and Mo. Investigation of the interaction between UZrC (6.0 mole % U–45.8 mole % Zr–48.2 mole % C) and the same four refractory metals at 1800°C for 50 hr showed that the stabilization of the carbide phase by the addition of Zr improves the diffusion characteristics. Electron-microprobe analyses of these diffusion couples were made, the results of which are discussed. Preliminary investigations of UO_2-refractory metal compatibility were completed at 1200, 1800, and 2000°C. Indications of transport of one or more of the fuel components through grain boundaries were observed. (auth)

33469 (HW-74429) PAPERS AND PROCEEDINGS OF THE X-RAY PREFERRED ORIENTATION MEETING HELD AT HAPO, JUNE 29 AND 30, 1961. W. Gary Jolley, ed. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 1962. Contract AT(45-1)-1350. 83p.

Proceedings of the x-ray Preferred Orientation Meeting are presented. Separate abstracts were prepared for 7 of the 8 papers. The remaining paper was previously abstracted for NSA. (M.C.G.)

33470 (HW-74429(p.14-25)) TEXTURE GRADIENTS IN URANIUM FUEL CORES. V. Morton and R. N. Thudium (National Lead Co. of Ohio, Cincinnati).

This paper appeared in NLCO-840.

Sampling techniques are described for the determination of texture gradients in uranium fuel cores in the longitudinal, tangential, and radial directions. Plots of the growth index, G_3, in these three directions as a function of radial positions are included for a thick-walled, hollow, cylindrical, uranium fuel core which was subjected to a rapid quench from the beta phase. (auth)

33471 (HW-74429(p.26-36)) PREFERRED ORIENTATION OF URANIUM. Daryl Gray (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

An x-ray diffraction technique for determining pole figures, based on the spiral-scanning concept advanced by Holden and using a spherical or hemispherical specimen was developed for application to the study of textures and texture variation in as-fabricated uranium rods or tubes. The method is described and pole figure data are presented. Studies of a ring of extruded tubing show that texture variations exist about the ring. There is a strong 110 component parallel to the extrusion axis and there is also a strong a-axis component parallel 15 degrees from the extrusion axis in the radial direction. From this, it was concluded that in determining orientation, sampling procedure should be planned to check the possibility of texture variations. (auth)

33472 (HW-74429(p.37-40)) COMPARISON OF X-RAY INTENSITY DATA— PEAK HEIGHT VERSUS PEAK AREA. W. Gary Jolley (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

X-ray studies are used to determine if there is any preferred orientation in any of the shipments of uranium cores. Studies were made to see if peak height measurements could be justifiably used for growth index calculations. Five alpha recrystallized uranium cores were cut, taking a ½-in. wafer from 3 areas on the core. Each ½-in. section was x-rayed 5 times for both 10 and 18 plane G_3 determination. It was concluded that for a quality control study that is used to determine trends in preferred orientation, peak height measurements have some merit. (M.C.G.)

33473 (HW-74429(p.41-4)) EFFECTS OF ETCHING ON PREFERRED ORIENTATION MEASUREMENTS. N. Crank and R. N. Thudium (National Lead Co. of Ohio, Cincinnati).

This paper appeared in NLCO-830.

The effects of the etching solution and etching time on preferred orientation measurements were studied to ascertain whether a uranium sample is subject to preferential attack during electrolytic etching. It was found that variations in etching time did not affect the observed orientation; but that a change of etching solutions did have a small, but statistically significant, effect. (auth)

33474 (HW-74429(p.45-58)) DETERMINATION OF GRAIN SIZE FROM STATISTICAL FLUCTUATION IN X-RAY DIFFRACTION INTENSITY. E. F. Sturcken, and W. E. Gettys (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). (TID-15736)

The particle size of KCl powder was measured by the x-ray statistical method developed by B. E. Warren. The measurements were made with a Norelco diffractometer. The particle size distribution of the KCl powder was measured by optical microscopy. Five x-ray runs on a sample of KCl powder gave an average value of 9.5 ± 1.5 microns, in good agreement with the most probable range of 7 to 11 microns obtained from the particle size distribution as measured optically. For uranium, Warren's expression for grain size must be modified because of the metal's high absorption coefficient. Since the penetration of x-rays is smaller than the grain dimensions, the theory must be developed in terms of "surface" diffraction rather than volume diffraction. The modified expression for grain size is $\langle D^2 \rangle = (3jA_\phi \Omega r\gamma/2\pi^2 \sin\theta)\,[\langle (Y-\overline{Y})^2\rangle/\langle \overline{Y}\rangle^2]$. Warren's expression was $\langle D^3 \rangle = (3jA_\phi \Omega r\gamma/2\pi^2\mu)\,[\langle (Y-\overline{Y})^2\rangle/\langle \overline{Y}\rangle^2]$. (auth)

33475 (HW-74429(p.59-66)) A NOTE ON THE GRAIN STRUCTURE AND ORIENTATION OF "DYNAPAK"-EXTRUDED URANIUM TUBES. Leonard Robins (Bridgeport Brass Co., Conn.) and Edward F. Sturcken (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Contract AT(07-2)-1.

Grain size and preferred orientation measurements were made on 2⅛-inch long section of "Dynapak"-extruded tubing from the second Dynapak-extrusion campaign. The grain size was extremely fine, even when compared to alpha-rolled uranium (6 microns versus 40 microns). Characteristics of the preferred orientation were: high "b"-axis"-type texture in the extrusion direction, with high contributions from (020), (041), (130), and (150) planes, and sharp texture gradients in the extrusion direction, with (130) decreasing and (020) and (041) increasing along the axis of the tube toward the ram. Because of the texture gradients the samples will not be used for irradiation tests. Samples with more uniform textures will be selected from a later extrusion campaign. (auth)

33476 (HW-74429(p.67-79)) PREFERRED ORIENTATION MEASUREMENTS WITH AN AUTOMATED X-RAY DIFFRACTOMETER. E. F. Sturcken (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). (TID-15739)

An automated diffractometer was developed and tested by comparing preferred orientation measurements made with the automated unit to those made by conventional methods on specimens of uranium and Zircaloy-2. Conclusions were as follows: the automated unit gives more precise data than conventional methods because of elimination of human errors in measurement and more reliable electronic detection, the program tape of Zircaloy-2 must have large peak-scanning intervals to allow for peak shifts and broadening, texture coefficients (TC) for parallel planes occurring at high 2θ angles are too small because of broadening and diffuse scattering, so peak-scanning intervals and background count positions must be selected with care, background fluctuations cause large errors for weak peaks, and the automated unit suffers minor breakdowns frequently. (auth)

33477 (NMI-7253) POWER REACTOR PROGRAM. Progress Report to Savannah River Operations Office, United States Atomic Energy Commission for the Period July 1, 1962 through July 31, 1962. S. Isserow, R. W. Anderson, and W. L. Larson (Nuclear Metals, Inc., Concord, Mass.). Aug. 31, 1962. Contract [AT(30-1)-1565].

U-350 ppm Fe-900 ppm Al alloys containing additions of silicon to 1100 ppm are evaluated. Metallographic examinations of the as-cast alloys show that the grain size is decreased with increasing silicon content, and a different type of second-phase structure is formed within the grains. Extrusion of the U-0.3 Al-0.18 Si alloy has shown that alpha working before coextrusion is not necessary for smooth core-cladding interfaces. Unsuccessful attempts to heat treat billet-size sections of this alloy indicate that a lower alloy content may be advantageous. In an effort to define the factors responsible for hardness transition temperatures in the 500°C range, uranium alloys containing 500 and 1000 ppm molybdenum were hot hardness tested. The hardness data suggest that the high hardness transition temperature is related to some critical distribution of a second phase. This behavior is more stable in alloys containing 1.0 and 1.5 wt % molybdenum than in lower alloys. A series of experiments improving the understanding of the brazing operation is expected to help obtain brazed end closures of better quality. The experiments show that the braze alloy will flow completely around the end plug if the components are properly heated, adsorbed gases do not affect the quality of the brazed closure, and voids are caused by shrinkage. (auth)

33478 (SC-4642(RR)) STRESS PULSE-TRAINS FROM MULTIPLE REFLECTION AT A ZONE OF MANY DISCONTINUTIES. A NOTATION FOR MACHINE SOLUTION. R. P. Reed (Sandia Corp., Albuquerque, N. Mex.). Aug. 1962. Contract [AT(29-1)-789]. 54p.

A numerical method is presented by which the amplitudes of the trains of pulses that result when a single simple stress pulse encounters a zone of many abrupt discontinuities in a slender rod may be calculated. The notational scheme employed enables the system of multitudes of individual progagating waves to be studied in terms of analogous number sets which may be mechanically generated. The notational concept and related operational rules were used to program the problem for solution with the IBM 704 computer. The program is briefly discussed. Illustrative examples were computed for rods of two to ten discontinuities. These were compared with a pulse reflected in a rod of an unlimited number of steps. (auth)

33479 (TID-16734) BIBLIOGRAPHY ON EFFECTS OF STRAIN RATE ON THE MECHANICAL PROPERTIES OF METALS (WITH ABSTRACTS AND PUNCHED CARD CODINGS). Interim Technical Report No. 62-1. A. W. Stephens and L. J. Demer (Arizona. Univ., Tucson. Coll. of Mines). Jan. 1962. For Sandia Corp., Albuquerque, N. Mex. Contract [AT(29-1)-789]. 164p. (SCDC-2847)

A bibliography was compiled of approximately 460 references on the effects of strain rate on mechanical properties. Abstracts of the references are included where available. This bibliography was designed for use with the detailed classification system of the ASM-SLA Committee for Metallurgical Literature Classification. Punched card coding information for use with this system is given for each reference in the bibliography. An author index is included. (auth)

33480 (UCRL-6262(Pt.2)) PHYSICAL PROPERTIES AND PHASE DIAGRAMS OF TEN REFRACTORY OXIDES. PART 2. JOURNAL LITERATURE—SELECTED BIBLIOGRAPHY. Zanier D. Lane, Mary Jane Tunis, Eileen A. Olmsted, James H. Kennedy, and Glenn R. Maynard (California. Univ., Livermore. Lawrence Radiation Lab.). July 1962. Contract W-7405-eng-48. 85p.

The bibliography contains information on the physical properties and phase diagrams of oxides of aluminum, beryllium, calcium, cerium, chromium, magnesium, tin, titanium, yttrium, and zirconium. References were taken from Chemical Abstracts, Ceramic Abstracts, Engineering Index, Nuclear Science Abstracts, Physics Abstracts, and Refractories Bibliography. Arrangement is alphabetical by author. (N.W.R.)

33481 (UCRL-6996) THE DIFFUSION OF COBALT IN PURE DELTA IRON. Richard J. Borg, David Y. F. Lai, and Oscar H. Krikorian (California. Univ., Livermore. Lawrence Radiation Lab.). July 12, 1962. Contract W-7405-eng-48. 13p.

The diffusion of Co in δ-Fe was measured using Co^{60} as the tracer. The diffusion penetrations are determined both by sectioning and by the residual activity method. The results are summarized by the following equation: $D = 5.5 \exp[-61.2 \times 10^3/RT]$. The energy of activation does not agree with the value of 68.3 kcal which was previously reported for the diffusion of Co in paramagnetic α-Fe. A lower energy of activation in the δ-phase, as compared to the α-phase was also observed in the case of iron self-diffusion. Within the combined limits of error the decrease is the same for both Fe and Co in δ-Fe. Furthermore, at 1450°C the diffusion coefficient is approximately one third that which would be expected from the extrapolation of the α results. (auth)

33482 (UCRL-10200) DISLOCATION MULTIPLICATION. J. Washburn (California. Univ., Berkeley. Lawrence Radiation Lab.). June 1962. Contract W-7405-eng-48. 30p.

The mechanisms by which dislocations can multiply are discussed. The dislocation substructures in deformed metals are compared to those in deformed ionic crystals. Multiplication is defined, and the cross-over mechanism of strain multiplication is described. The annihilation mechanism of multiplication, the double cross-slip mechanism, boundary multiplication, and damage in slip bands are discussed. (M.C.G.)

33483 (UNC-5033) FUEL CYCLE DEVELOPMENT PROGRAM. Quarterly Progress Report, April 1 to June 30, 1962. (United Nuclear Corp. Development Div., White Plains, N. Y.). Aug. 31, 1962. Contract AT(30-1)-2374. 22p.

The progress in developing low cost uranium oxide and

carbide fuels by lowering the cost of fabrication processes is reported. Three full scale fuel rods containing uranium dioxide pellets sintered by the low temperature process were fabricated and forwarded to the VBWR for irradiation. The 5% enriched pellets were obtained by sintering at 1150°C in nitrogen to produce densities of 95 to 96% of theoretical. Final measurements of thermal expansion of triplicate specimens representing 4.4 wt % carbon sintered uranium carbide and 4.8 wt % carbon cast uranium carbide were made. The average coefficients of linear thermal expansion over the range from room temperature to 1000°C were 11.8×10^{-6} and 11.0×10^{-6} mm/mm-°C, respectively. Average coefficients for single specimens representing 4.8 wt % carbon sintered material and 5.2 wt % carbon cast uranium carbide were found to be 10.9×10^{-6} and 11.5×10^{-6} mm/mm-°C, respectively. (auth)

33484 (WADD-TN-61-18(Pt.II)) RESEARCH AND DEVELOPMENT ON ADVANCED GRAPHITE MATERIALS. Final Report. (National Carbon Co. Advanced Materials Lab., Lawrenceburg, Tenn.). Apr. 1962. Contract AF 33(616)-6915. 143p.

A review is given of activities over the period October 15, 1960 to October 15, 1961 on a three year program for the research and development of materials, experimental techniques, and equipment for development of premium quality, reproducible graphite-base materials suitable for missile and astronautic applications. Progress is reported on research and development in the study areas of raw materials, fabrication, and material characterization and evaluation. (auth)

33485 (WAPD-DLE-319) PHOTOELASTIC FROZEN STRESS STUDY OF THE EFFECTIVE ELASTIC CONSTANTS OF PERFORATED MATERIALS. Progress Report. Research Report 100FF996-R7-X. R. C. Sampson (Westinghouse Electric Corp. Research Labs., Pittsburgh). May 29, 1959. For Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh. Contract NObs-67500. 26p.

"Frozen-stress" tests were performed on relatively small perforated specimens subjected to uniaxial bending, and to uniform tension. Deformations were measured and the effective elastic constants of the perforated material were determined. The results were compared to the properties predicted by the theories of Horvay and Malkin. The theories appear to be inadequate in their present form. (auth)

33486 (AEC-tr-5391) INVESTIGATIONS OF EPITAXY. Ernst Bauer. Translated for Oak Ridge Gaseous Diffusion Plant, Tenn. from Z. Krist., 107: 265-89(1956). 32p.

The epitaxial growth of LiF, NaF, CaF_2, BaF_2, and MgF_2 on NaCl and mica was investigated electron microscopically and by electron diffraction. Results are discussed including qualitative statements based on the theory of nucleus formation. (J.R.D.)

33487 (EURAEC-243) INVESTIGATION OF ZIRCONIUM ALLOYS WITH NIOBIUM AND TIN WITH RESPECT TO THEIR USE AS CLADDING MATERIAL IN WATER-COOLED NUCLEAR REACTORS. Quarterly Report No. 3 (2nd year), October–December 1961. (Metallgesellschaft A.G., Frankfurt am Main). Jan. 22, 1962. Work Performed under United States–Euratom Joint Research and Development Program. Contract 047-61-4-RDA. 65p. A translation.

Investigation of the zirconium rich corner of the system Zr–Nb–Sn determined that the solubility of tin in zirconium is not substantially influenced by niobium additions up to 10%. In the temperature range of 575 to 750°C at least 2% tin is dissolved. Texture investigations on extruded tubes of the alloy Zr–3Nb–1Sn resulted in a fiber texture with the $[10\bar{1}0]$ plane parallel with the tube axis. Scattering about an ideal position became less with increased extrusion ratio. On the basis of the corrosion behavior of various heat-treated samples the final anneal temperature was fixed at 580 ± 10°C. The investigation on the influence of hydrogen on the structure of Zr–Nb and Zr–Nb–Sn alloys showed that hydrogen stabilized the β-Zr-phase in Zr–Nb alloys and lowered the transformation temperature. A hydrogen content of 0.1% led to a decrease in the creep rate in the alloy Zr–3Nb–1Sn and Zircaloy-2 and to an increase in the creep rate of the alloy Zr–2Nb. Testing the weld-joints of the alloy Zr–3Nb–1Sn indicated that an elongation of ~10% with the strength of the base material can be attained. After a heat treatment the corrosion resistance as well as the mechanical properties of the base material can be attained. (auth)

33488 REMARKS ON THE ELASTIC CONSTANTS AND TEMPERATURES OF MARTENSITIC TRANSFORMATION IN THE Li–Mg ALLOYS. D. B. Masson (Washington State Univ., Pullman). Acta Met., 10: 986-7(Oct. 1962).

The correlation between the elastic constants and the martensitic transformation temperature is discussed. Data for the Li–Mg alloys are tabulated which show that the transformation occurs at higher temperatures as the elastic anisotropy increases with change in Mg content. (D.L.C.)

33489 X-RAY DIFFRACTION STUDIES OF THE THERMAL EXPANSION COEFFICIENTS OF MANGANESE AND COBALT MONOSILICIDES. N. N. Zhuravlev and A. A. Stepanova. At. Energ. (USSR), 13: 183-4(Aug. 1962). (In Russian)

The compounds MnSi and CoSi are considered to be useful for the construction of high-efficiency thermoelectric generators; for this application their thermal expansion coefficients must be known. The materials investigated consisted of dark gray powders having a FeSi type structure and contained about 5 to 10% of unknown impurities. The dimensions of the elementary cells of MnSi and CoSi at room temperature were found to be 4.558 ± 0.001 Å and 4.447 ± 0.001 Å, respectively, agreeing well with G. V. Samsonov's data (Silitsidy i ikh ispol'zovanie v tekhnike, Silicides and their industrial applications, Edition of the USSR Academy of Sciences, 1959). X-ray diffraction pictures were taken at several temperatures up to 800°C. From these data the following temperature coefficients were calculated: MnSi, $(13.3 \pm 1.0) \times 10^{-6}$/°C; CoSi, $(11.1 \pm 1.0) \times 10^{-6}$/°C. (TTT)

33490 THE CHARACTERISTICS OF SOME REFRACTORY COMPOUNDS OF THE TRANSITION METALS USED AS THERMOELECTRIC CONVERTERS. G. V. Lashkarev and G. V. Samsonov. At. Energ. (USSR), 13: 187-8(Aug. 1962). (In Russian)

Increasing the temperature gradient between the hot and cold junctions enhances the efficiency of a thermogenerator. The thermoelectric properties of the refractory compounds of the transition elements are of interest in respect as some of them possess high thermoelectromotive force (temf.) and low electric resistance, thus representing potential thermoelectric converters. For this reason the $z = (\alpha^2)/(\varkappa\rho)$ parameters of some refractory compounds were calculated, where α = coefficient of temf.; $\varkappa$ = coefficient of thermal conductivity, and ρ = specific heat conductivity. Simultaneously, the efficiency of the thermogenerators was calculated for a hot joint temperature of 1200°K and a cold joint temperature of 400°K. Silicides such as $CrSi_2$, MnSi, $MnSi_2$, and $ReSi_2$ were considered as they are

similar to semiconductors in their behavior and have a relatively high efficiency, reaching 13% for MnSi. The only nitride of a transition metal with high temf. was CrN. For the best couple, a value of $z = 3.5 \times 10^{-4}$ was obtained. The carbides and borides are similar to metals and were not expected to possess high efficiencies; however the Ca, Sr, and Ba hexaborides approach the properties of semiconductors, having negative temf. values of about 30 microvolt/°C. (TTT)

33491 THE INTERSTITIAL-DISLOCATION DAMPING INTERACTIONS IN COLUMBIUM. Donald Herbert Boone (Univ. of Illinois, Urbana). Dissertation Abstr., 23: 589 (Aug. 1962).

A study of niobium was undertaken to determine if cold-work peaks were found in other bcc metals beside iron, and if found, to study their characteristics, and determine a model for the peak. Cold-work peaks were found in niobium–nitrogen (also tantalum–nitrogen) alloys. The characteristics of the peak were found to be divided into two parts; a low nitrogen (LN) part, below 0.018%, and a high nitrogen (HN) part above. For the LN peak the height was a linear function of initial nitrogen content while only slightly dependent upon the amount of deformation up to 5%. The characteristics of the HN peak were relatively insensitive to both nitrogen content and deformation. A model is presented which explains the observed characteristics of the cold-work peaks. The relaxation is pictured as occurring in clusters of interstitials around the dislocations. The clusters can interact with an externally applied stress by changing shape or orientation. The high relaxation strength is the result of the interaction of the interstitials in the clusters and the increase in relaxation time is the result of the cluster's increase in size. The HN peak model is identical with that proposed for the LN peak; its characteristics determined by the nitrogen content of the solubility limit at approximately the peak temperature. Nitrogen contents in excess of this amount forms precipitates which have no effect upon the relaxation.

33492 GAS-METAL EQUILIBRIUM AND THE NIOBIUM–NITROGEN TERMINAL SOLID SOLUTION. James Richard Cost (Univ. of Illinois, Urbana). Dissertation Abstr., 23: 589-90(Aug. 1962).

The idealized behavior of a hypothetical gas-metal binary system is discussed in terms of a three dimensional phase diagram in which the variables are pressure, temperature, and composition. The phase diagram is then applied to the niobium–nitrogen system, and comparisons are made with the hypothetical ideally-behaving system. Various assumptions of ideality are made as follows: Henry's Law and Sievert's Law are both obeyed in the solid solution range; the activity of the solid solution is that of the pure metal; the composition of the second solid phase which forms is constant; and the gas obeys the ideal gas laws at all pressures and temperatures involved. It was found that when the variables are plotted with pressure and composition on logarithmic scales and temperature on a reciprocal scale, the surfaces are simplified so that they become planes and cylindrical surfaces. Analytical treatment of the equations for the various surfaces was found to substantiate the additivity of the heats involved in the various gas-metal reactions. Experimentally the Nb–N system was studied in order to determine to what extent a real system follows the idealized one. For the solid solution, Sievert's Law was found to be obeyed and the partial molar heat of solution of the gas in the metal was determined to be constant within the experimental error; it has a value −46 kcal per g-atom. Nb_2N was found to be the nitride in equilibrium with the solid solution in the temperature range from 300 to 2230°C; it has a heat of formation of −67 kcal per g-atom of nitrogen. The terminal solubility of nitrogen in niobium metal was found to obey the van't Hoff relation from 1150 to 2230°C, and the possible low temperature deviations are discussed. Comparison of the Nb–N results with those for an idealized system indicate that above 1150°C nitrogen reacts with niobium so that the idealized hypothetical phase diagram is a good approximation. The equations for the plane surfaces of the diagram are given, and the entropies for the various reactions were found to be in agreement both with theory and with the results obtained for comparable systems. It was concluded that the nitrogen atoms are a comfortable fit in the niobium lattice and that there is very little interaction between adjacent nitrogen atoms as they exist in solution.

33493 THE INFLUENCE OF ELECTRON INTERACTIONS ON SOME PROPERTIES OF METALS. Seth David Silverstein (Univ. of Illinois, Urbana). Dissertation Abstr., 23: 670(Aug. 1962).

The influence of electron interactions on the electronic specific heat and the static paramagnetic spin susceptibility was calculated using a momentum transfer interpolation procedure similar to that employed for the correlation energy. In the application to the alkali metals, the periodicity effects are taken into account by the introduction of an effective mass in the kinetic energy term. A study was also made of the paramagnetic response of an electron gas to an inhomogeneous time dependent magnetic field. A discussion is presented about the nuclear magnetic resonance experiments which yield information concerning the nature of the response.

33494 EFFECT OF HAFNIUM ON THE KINETICS OF THE RECOVERY AND RECRYSTALLIZATION OF α-IRON. L. N. Larikov, E. E. Zasimchuk, and V. S. Shkirov (Inst. of Metal Physics, Academy of Sciences, Ukrainian SSR). Dopovidi Akad. Nauk Ukr. RSR, No. 7, 906-9(1962). (In Ukrainian)

X-ray methods were used to study the effect of slight additions of hafnium (up to 1%) on the rate of growth of recrystallization centers G in deformed (~98%) ferrite at different temperatures, as well as on the kinetics of the change in width B of x-ray interferential lines. Slight additions of hafnium greatly retard the growth of centers. A weak effect of the additions on the rate of changes β, however, indicated a very slight solubility of hafnium in α-iron at temperatures below 500°C. The observed effect of the strong influence of hafnium on G is evidently due primarily to the formation of disperse particles of the intermetallide phase (Fe_2Hf) during the preliminary thermal treatment of the alloys. (auth)

33495 MAJOR REFRACTORY METALS. Jack Chelius. Ind. Res., 4: No. 8, 36-9(Sept. 1962).

The demand for high-temperature metals has resulted in the extensive development of four refractory metals: W, Mo, Ta, Nb, and their alloys. Comparisons are made between the four metals on the basis of corrosion resistance, gas susceptibility, high-temperature properties, and thermal conductivity. Possible future developments in refractory metallurgy are described briefly. (D.L.C.)

33496 STRUCTURE AND PROPERTIES OF ZIRCONIUM DIBORIDES WITH IRON, COBALT, AND NICKEL. V. F. Funke and S. I. Yudovskii. Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Met. i Toplivo, No. 4, 126-32(July–Aug. 1962). (In Russian)

The structure and properties of Zr–B–Fe(Co, Ni) with ZrB_2–Fe(Co, Ni) cross sections are investigated. It was

found that complex zirconium borides and ferrous metals with FeB(Co_3B, Ni_3B) structures are formed. Phase diagrams constructed for Zr–B–Fe indicate that ZrB_2–Fe (Co, Ni) are binary zirconium borides. (R.V.J.)

33497 LOW-FREQUENCY NEGATIVE RESISTANCE IN THIN ANODIC OXIDE FILMS. T. W. Hickmott (General Electric Research Lab., Schenectady, N. Y.). J. Appl. Phys., 33: 2669-82(Sept. 1962).

Negative resistance and large current densities are observed in the direct-current–voltage characteristics of five metal-oxide-metal sandwiches prepared from evaporated metal films. The systems studied and their voltages for maximum current are: Al-SiO-Au, 3.1 v; Al-Al_2O_3-Au, 2.9 v; Ta-Ta_2O_5-Au, 2.2 v; Zr-ZrO_2-Au, 2.1 v; and Ti-TiO_2-Au, 1.7 v. For aluminum oxide, which is extensively studied, the voltage for maximum current is independent of film thickness for films between 150 and 1000 Å thick; the phenomenon is not field dependent. Peak-to-valley ratios of 30:1 and current densities of 10 amp/cm^2 are typical. Maximum current densities at peak voltage are 25 amp/cm^2; minimum current densities are 0.01 amp/cm^2. Switching time from peak current to valley current is <0.5 μsec, but negative resistance is not found for 60-cycle voltages. Establishment of the d-c characteristics and dependence on temperature and atmosphere are described. Electron emission from aluminum oxide sandwiches can occur at 2.5 v. Space-charge-limited currents in the insulator provide a possible mechanism for the current-voltage curves and large currents below the voltage for maximum current through the oxide films. The mechanism responsible for negative resistance is uncertain. (auth)

33498 INTERDIFFUSION OF GASES IN A LOW PERMEABILITY GRAPHITE AT UNIFORM PRESSURE. R. B. Evans, III, G. M. Watson, and J. Truitt (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 33: 2682-8(Sept. 1962).

An experimental investigation of the interdiffusion behavior of gases in a low-permeability graphite was performed by sweeping the opposite faces of a graphite septum with helium and argon at uniform pressure and measuring the diffusive flux of both gases. The objectives were to ascertain the diffusion mechanism, to verify the applicable equations and associated theories, and to determine the parameters required to use these equations. At all experimental pressures, contributions of both normal and Knudsen diffusion effects were detectable via the pressure dependence of the diffusion fluxes. It was found that a dusty-gas model formed an excellent basis for correlating the results. The dusty-gas model yielded flux equations that predicted the diffusion behavior over a wide range of pressures for particular gas concentrations at the boundaries. Only two experimentally determined parameters (characteristic of the gases and graphite) were required. These were an effective normal-diffusion coefficient obtained through interdiffusion experiments and a Knudsen coefficient obtained through single-gas (permeability) experiments. The procedures used to evaluate these parameters in terms of the experimental data were described. (auth)

33499 EFFECT OF SOME RARE-EARTH ELEMENTS ON THE hcp-bcc TRANSFORMATION OF ZIRCONIUM. L. Ianniello (Argonne National Lab., Ill.) and A. Burr. J. Appl. Phys., 33: 2689-90(Sept. 1962).

Thermal dilation measurements through the temperature of transformation of some zirconium–rare-earth alloys were utilized to compare the effect of the elements Nd, Y, Dy, Ho, and Er on the hcp-bcc transformation temperature of Zr. Binary alloys were vacuum-arc melted and concentrations of the individual rare earths were varied up to slightly beyond their solubility limits. All the elements investigated raised the transformation temperature similarly. Electrical resistivity measurements at room temperature and below also showed the same trend of equal change in property, irregardless of the alloying element, at least up to the solubility limit. (auth)

33500 THE EFFECT OF ZIRCONIUM ON INTERNAL FRICTION IN COLUMBIUM. Patricia M. Bunn, D. G. Cummings, and H. W. Leavenworth, Jr. (Pratt and Whitney Aircraft Corp., Middleton, Conn.). J. Appl. Phys., 33: 3009-13(Oct. 1962).

The effect of Zr on internal friction in Nb was investigated over the frequency range of 0.5 to 10 cps. A peak was observed, which was attributed to the diffusion of oxygen in the vicinity of zirconium atoms. The normal Nb oxygen peak was not observed until approximately 0.14 wt % oxygen was added to the specimens. The normal Nb nitrogen peak was readily observed, but a Zr nitrogen peak was not observed until oxygen concentration was reduced below 0.1 wt %. These observations were explained on the basis of a strong attraction between zirconium and oxygen atoms. The diffusivity of zirconium in Nb at 1930°C was determined. A value for D_0 and the activation energy were calculated so that the diffusivity at any temperature could be obtained from the expression D = 0.57 exp 87 000/RT. (auth)

33501 DIFFUSION IN COBALT–NICKEL ALLOYS. Ken-ichi Hirano, R. P. Agarwala, B. L. Averbach, and Morris Cohen (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 33: 3049-54(Oct. 1962).

The self-diffusivities of Co^{60} and Ni^{63} in cobalt–nickel solid solutions exhibit a greater activation energy below the Curie temperature (T_c) than above. Values of ΔQ = Q (ferromagnetic) – Q (paramagnetic) are approximately equal to RT_c. This observation is interpreted to indicate that the increment in activation energy arises from an increase in the formation energy of a vacancy in the ferromagnetic lattice, with the additional binding energy arising from the interaction of a spin with the Weiss field. (auth)

33502 HIGH TEMPERATURE URANIUM FUELS. Karel Seidl (Inst. of Nuclear Physics, Czechoslovak Academy of Sciences, Řež). Jaderná energie, 8: 225-30(July 1962). (In Czech)

Needed characteristics of high alloyed uranium and its compounds, especially uranium monocarbide, are discussed. (auth)

33503 STRUCTURAL CHANGES OF URANIUM DURING THERMAL CYCLING. František Šlancar and Václav Novotný. Jaderná energie, 8: 239-40(July 1962). (In Czech)

An evaluation was made of the structural changes of uranium by metallographic methods and an explanation of the mechanism of the changes is given. Commercial quality natural uranium in the cast, rolled, rotary forged, and extruded state was used. Thermal cycling in the alpha phase was carried out in the temperature range of 50–550°C up to 2000 thermal cycles (t. c.). Structural changes were investigated statistically by means of special instruments and of normal metallographic microscope. The mechanism of structural changes was investigated with the aid of the high temperature microscope in individual phases of the thermal cycles. Special attention was given to grain decay during thermal cycling, and to the origin of microcracks. Original grain of uranium decays during thermal cycling. The percentage of decayed grains varied directly with the number of cycles up to 600 t. c. The grain size varied no more above this number of cycles. From the analysis of

microcrack positions it was evident that they were on the grain boundary. The origin and spreading of microcracks may be influenced by inclusions, namely of UO-type, by complexes U (OCN) and other. After further thermal cycling microcracks originated at the inclusions were spread into matrix material. The microcrack number and length varied directly with the number of thermal cycles. The results demonstrate a substantial influence of the kind of uranium production on the origin of microcracks. (auth)

33504 THERMIONIC PROPERTIES OF UC, (U,Zr)C AND ZrC. Yoshihiko Takada, Shosuke Imoto, and Tadao Sano (Osaka Univ.). Nippon Genshiryoku Gakkaishi, 4: 335-9(Aug. 1962). (In Japanese)

With relation to thermionic power conversion, thermionic emission measurements were carried out on carbide-coated tungsten filaments in the temperature range of 1,400 to 2,100°K. Carbide coating was done by electrophoresis in n-butyl alcohol suspending carbide powder. From the Schottky plots for d-c field as high as 6×10^6 v/m, thermionic saturation currents were estimated. Richardson plots showed that Richardson constant A and work function ϕ was 100 A/cm$^2 \cdot$deg^2, 3.8 v for UC; 420 A/cm$^2 \cdot$deg^2, 4.2 v for $U_{0.5}Zr_{0.5}C$; and 360 A/cm$^2 \cdot$deg^2, 4.2 v for ZrC, respectively. The result for ZrC rather agreed with the result by Pidd, et al., but an abnormally large A value which Pidd, et al., had obtained for UC and (U,Zr)C was not observed. Thermionic characteristics of UC seemed to be complex. (auth)

33505 LOW-FREQUENCY MECHANICAL RELAXATION PEAKS IN COLD-WORKED BODY-CENTERED CUBIC METALS. R. De Batist (Studiecentrum voor Kernenergie, Mol, Belg.). Phys. Status Solidi, 2: 661-7(1962). (BLG-110). (In English)

Internal damping is investigated for body-centered cubic transition metals (W, Mo, Nb, Ta), using a torsional pendulum, for temperatures between 80 and 300°K. Cold-worked specimens are found to have a relaxation peak between 200 and 250°K, which can in general be resolved into several components. By comparison with high-frequency measurements, these component peaks are thought to consist of two sets, one due to the relaxation of dislocations (Bordoni peaks) and the other due to the relaxation of the point defects loosely bound to dislocation lines. (auth)

33506 BEARING MATERIALS AND LUBES FOR NUCLEAR CONTROL SYSTEMS. Walter Koerner (Marquardt Corp., Van Nuys, Calif.). Space/Aeronautics, 38: No. 4, 68-9(Sept. 1962).

Screening tests are being conducted on various bearing materials and lubricants. Two oxide-bonded cermets (Haynes LT-1B and LT-2) and an intermetallic compound (GE F-48) gave good results, and results of tests on these unlubricated materials in various combinations are given. The effects of precious-metal film lubricants on the friction of LT-1B and LT-2 are given. Tests were conducted on MoS_2–PbS films with B_2O_3 as binder. (D.L.C.)

33507 INVESTIGATION OF THE STRUCTURE OF TANTALUM TO 2700°C BY X-RAY DIFFRACTION. B. M. Vasutinskii, G. N. Kartmasov, and V. A. Finkel (Inst. of Physics and Tech., Academy of Sciences, Kharkov). Ukr. Fiz. Zh., 7: 661-3(June 1962). (In Ukrainian)

The structure of Ta was investigated in a high-temperature x-ray camera. The values of the parameters of the bcc lattice of Ta and the coefficients of linear expansion are determined. (auth)

33508 VAPORIZATION OF THE CARBIDES OF URANIUM, THORIUM, AND PROTACTINIUM. H. K. Lonsdale and J. N. Graves (General Atomic Div., General Dynamics Corp., San Diego, Calif.). IAEA Preprint No. SM-26/33. 28p. (GA-3015). (In English)

To be published in proceedings of IAEA Symposium on the Thermodynamics of Nuclear Materials, Vienna, May 21-25, 1962.

Vapor pressure measurements were made on the carbides of uranium, thorium, and protactinium in the presence of an excess of carbon using the Knudsen effusion technique. The experiments involving protactinium were carried out with a very dilute solid solution of protactinium carbide (presumably the dicarbide) in thorium dicarbide in which Pa^{233} was produced by the neutron activation of Th^{232}. In this way it was possible to study simultaneously the vapor pressure of thorium over thorium dicarbide and the vaporization of protactinium from the solid solution. The measurements of the vapor pressure of uranium over uranium dicarbide were carried out over a temperature range of 2000 to 2900°K and a uranium vapor pressure range of 3×10^{-10} to 1×10^{-5} atm. Over the entire range the vapor pressure may be represented by the equation log P (atm) = $-29500 \pm 1200/T + 5.26 \pm 0.30$. This results in a second-law heat of vaporization of approximately 135 kcal/mole and a heat of formation of uranium dicarbide of approximately 30 kcal/mole. A heat of this magnitude applies down to 298°K if, as is estimated, the ΔC_p for the vaporization process is small. There is evidence of positive curvature in the vapor pressure plot above the uranium of positive curvature in the vapor pressure plot above the uranium dicarbide–carbon eutectic temperature (ca 2700°K). Thorium dicarbide was studied over approximately the same range of vapor pressures. A preliminary analysis of the results indicates that the pressure may be represented by the equation log P (atm) = $-33400/T + 5.77$. From a second-law treatment of the data, it appears that the heat of formation of ThC_2 is less than that of UC_2. Results for the protactinium system yield a second-law heat of vaporization similar to that of ThC_2. The Pa pressure over the carbide, calculated assuming ideal behavior, is less than that of Th indicating either (1) a fairly large negative deviation from ideal solid solution behavior in the dilute PaC_2–ThC_2 system or (2) that the vapor pressure of PaC_2 is less than that of ThC_2. (auth)

Radiation Effects

Refer also to abstracts 32893, 32900, and 34133.

33509 (AFSWC-TDR-62-15) REENTRY OF SNAP REACTOR BERYLLIUM REFLECTORS. EFFECT OF FAST NEUTRON PRODUCED INTERSTITIAL HELIUM NUCLEI. A. Vampola (General Dynamics/Astronautics, Space Science Lab., San Diego, Calif.). Mar. 1962. Contract AF29(601)-4893. 6p. (AD-273169)

The effects of interstitial He nuclei produced in the Be by fast neutrons are discussed as a possible mechanism of Be degradation and hence a contributing mechanism of dispersal. The sizable cross sections for production of He^4 under fast neutron bombardment of Be indicated that interstitial He nuclei would be produced within the Be. It was shown that the total gas volume involved was too small to produce significant changes in density, yield strength or brittleness of the Be. The irradiated reflector metal, therefore, should react in the same manner as unirradiated Be upon reentry. (auth)

33510 (BMI-APDA-660) IRRADIATION STUDIES OF URANIUM-10 w/o MOLYBDENUM FUEL ALLOY. John E. Gates, William E. Murr, Arthur A. Bauer, and Frank A.

Rough (Atomic Power Development Associates, Inc., Detroit and Battelle Memorial Inst., Columbus, Ohio). Jan. 26, 1961. Contract AT(11-1)-756. 120p.

Bare and zirconium-clad uranium-10 wt % molybdenum specimens were irradiated in NaK-filled capsules in the MTR. Irradiation conditions varied to include central-core temperatures ranging from 300 to over 1200°F, fuel burnups ranging from 0.36 to over 3.0 total at.% and fission rates in the range of 0.35 to 1.9×10^{14} fissions/(sec)(cm^3) of alloy. Other parameters studied included the effects of heat treatment, changes in composition, different fabrication techniques, and changes in cladding thickness on the behavior of the fuel alloy. The objective of the irradiations was to determine the behavior of the fuel alloy under conditions approaching as closely as possible those to be encountered in the Enrico Fermi Atomic Power Plant as they were known at the time. The results indicated that the volume of the fuel alloy would increase conservatively at a rate of about 3.0% per at.% burnup as long as the critical temperature of 1000 to 1100°F was not exceeded and the gamma phase of the alloy did not transform during irradiation. If the critical temperature was exceeded, the alloy swelled until rupture or complete disintegration occurred. The occurrence of transformation during irradiation was noted at burnups in the range of 2.5 total at.% at fission rates of 1.5×10^{14} to 1.9×10^{14} fissions/(sec)(cm^3) and temperatures of 800 to 1000°F. The alloy was normally maintained in the gamma phase during irradiation, even at temperatures below 1100°F and at fission rates in the range of 0.7×10^{14} fissions per sec. Transformation during irradiation was accompanied by excessive swelling of the alloy. (auth)

33511 (CEND-162) IRRADIATION TESTING OF CERAMIC FUELS. Progress Report, February 1, 1962–June 15, 1962. G. Zuromsky and W. P. Chernock (Combustion Engineering Inc. Nuclear Div., Windsor, Conn.). July 1962. Contract AT(30-1)-2936. 65p. (NYO-2997)

The phase behavior, properties, and irradiation stability of $CaO-UO_2-ZrO_2$ and CeO_2-UO_2 systems were investigated. The composition limit of 10.2 mole % uranium dioxide was established as a value safely within the single phase cubic region for the zirconium oxide-base compositions. For the cerium oxide-base compositions, uranium dioxide compositions of 21 mole % form two-phase cubic structures; however heat treatment of these samples in argon resulted in a return to single-phase cubic structures. Thermal expansion coefficients at temperatures to 1350°C for the zirconium oxide-base compositions containing uranium dioxide contents of 4, 10.2, and 12 mole % were found to be 9.83×10^{-6}/°C, 10×10^{-6}/°C, and 10×10^{-6}/°C, respectively; the melting points ranged from 2635 to 2630°C. The melting points of the cerium oxide-base compositions with 7 and 21 mole % uranium dioxide were established as 100°C below the liquid temperatures of 2420 and 2335°C, respectively. Corrosion tests showed that the zirconium-oxide-base compositions increased in weight in flowing 625°C steam and 360°C degassed water, while cerium-base compositions showed weight losses. The zirconium oxide-base compositions were successfully thermal cycled to 2400°C by internal heating. (N.W.R.)

33512 (CVNA-152) RELATIVE THERMAL EXPANSION OF UO_2 FUEL INPILE. Terminal Report. William E. Baily (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). June 1962. For Carolinas Virginia Nuclear Power Associates, Inc., Charlotte, N. C. Contract AT(30-1)-2289. 106p.

Experiments were conducted to measure the axial expansion of UO_2 under irradiation. These experiments utilized a linear motion differential transducer which continuously recorded the change in UO_2 pellet column height as a function of time. A tungsten-tungsten 26% rhenium thermocouple was employed to measure fuel center temperatures in excess of 2100°C. The results of these tests indicated that the amount of UO_2 expansion is dependent on the size of the gap between the fuel pellet and cladding. Increases in fuel rod power level caused thermal expansion which may be partially balanced by fuel sintering. (auth)

33513 (EURAEC-403) SOLID STATE NEUTRON DETECTOR. Quarterly Report No. 7, April 1–June 30, 1962. (Mol, Belgium. Centre d'Étude de l'Énergie Nucléaire). Work performed under United States–Euratom Joint Research and Development Program. Contract 079-61-10RDB. 12p.

In an investigation of the relaxation processes of defects during heat treatment, pulse annealing experiments were carried out on p- and n-type SiC single crystals, after irradiation in the BRl reactor at 80°C. Isochronal temperature pulses of about 30 min were given at 100 to 700°C. The conductivity and Hall coefficient were measured at the pulse temperature and at a reference temperature. It was found that no measurable annealing of the neutron bombarded material occurs below 400°C. Further studies of the radiation effects by electrical and optical measurements on high purity SiC single crystals, could not be performed as a consequence of the shut-down of the BRl reactor for the release of the stored Wigner energy. (auth)

33514 (GA-3410) EFFECT OF NEUTRON IRRADIATION ON MATERIALS SUBJECTED TO MULTI-AXIAL STRESS DISTRIBUTIONS. Quarterly Report for the Period Ending June 30, 1962. T. A. Trozera (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Aug. 13, 1962. Contract AT(04-3)-167. 9p.

Activities in a program to determine the effects of neutron irradiation on A-302B steel are reported. Plans are discussed concerning performance tests on tensile, notched tensile, tube, and Charpy specimens. An irradiation capsule design was finalized. A theoretical analysis of the critical conditions arising in a tube subjected to both internal pressure and axial load is included. (J.R.D.)

33515 (GEAP-4053-2) ACCURATE NUCLEAR FUEL BURNUP ANALYSES. Second Quarterly Report, March 1962–May 1962. B. F. Rider (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). July 1, 1962. Contract AT(04-3)-189. 12p.

Completion of the Gev-1 capsule is reported. Approval for irradiation of this capsule in the MTR was obtained. Research on the chemistry of Mo using Mo^{99} as tracer is reported. Several possible solvent extraction procedures were examined. The mass spectrometric behavior of Mo was investigated; a method of carbon reduction of MoO_3 to metal on the filament was used. (J.R.D.)

33516 (NAA-SR-Memo-7428) IRRADIATION DAMAGE AND SUBSEQUENT RECOVERY IN METALS THROUGH MEASUREMENTS OF ELASTIC MODULES AND DECREMENT. J. C. Robinson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 1, 1962. 19p. Contract [AT-11-1-GEN-8].

The technical problems and equipment used in measuring the radioinduced lattice defects in crystalline solids are discussed. The technical problems are primarily of equipment characteristics and operation control with respect to radiation and temperature control. The cryostat used is described along with the mechanical and electrical systems used in the measuring systems. (N.W.R.)

33517 (NYO-10444) LATTICE DEFECTS OF QUARTZ INDUCED BY FAST NEUTRON IRRADIATION. Technical Report No. 1. S. Weissmann, T. Imura, K. Nakajima, and S. F. Wisnewski (Rutgers Univ., New Brunswick, N. J. Coll. of Engineering). Sept. 1962. Contract AT(30-1)-2937. 27p.

Lattice defects in natural and synthetic quartz crystals induced by an exposure to fast neutron irradiation ranging from 1×10^{19}–1.5×10^{20} nvt were studied by x-ray and transmission-electron-microscopy methods. A quantitative strain analysis based on the x-ray divergent beam method yielded the principal strains and their directions as a function of radiation dose. Major differences with regard to the magnitude and directions of the strains were found between crystals cut parallel to the basal (00.1) plane (z-cut) and those cut perpendicular to it (x-cut), while virtually no difference was observed between natural and synthetic crystals. A close correlation was established between the alignment of clusters rich in interstitial Si atoms directly observed by transmission electron microscopy, and the strain distribution disclosed by the x-ray method. The results were interpreted in terms of a mechanism of dynamic crowdions giving rise to the formation of clusters of interstitial atoms aligned in directions relative to the open screw channels of the quartz structure. At large radiation doses interaction of the densely populated clusters occurred which appeared to be aided by thermal spikes and which resulted in the formation of a stable network of lattice defects. Crystals irradiated 1×10^{20} nvt still exhibited a considerable degree of crystallinity, as evidenced by the extinction contour lines seen in the electron microscope. (auth)

33518 (ORNL-TM-311) RADIATION EFFECTS ON FUELED BeO. J. Giles Morgan and M. F. Osborne (Oak Ridge National Lab., Tenn.). Oct. 4, 1962. Contract W-7405-eng-26. 26p.

Irradiation effects studies were made on BeO containing fine dispersions of UO_2 and UO_2-ThO_2. The dimensional stability and fission gas release were measured after irradiations of up to 2200°F and 97,000 Mwd/MTU. The largest dimensional increases occurred in those samples containing UO_2, and averaged 2%. The samples with UO_2-ThO_2 as the dispersed fuel increased dimensionally about 0.5%. The fission gas release from both type fuels was small, less than 0.3% based on krypton-85. (auth)

33519 (ORNL-TM-337) RESULTS OF TENSILE TESTS PERFORMED ON MATERIALS EXPOSED IN THE HOMOGENEOUS REACTOR EXPERIMENT NO. 2 BLANKET AND LOW-FLUX-CORE REGION. J. J. Prislinger (Oak Ridge National Lab., Tenn.). Oct. 2, 1962. Contract W-7405-eng-26. 23p.

Tensile specimens of various alloys of zirconium and titanium and a variety of austenitic stainless steels and Incoloy were exposed in the blanket and low-flux core regions of the Homogeneous Reactor Experiment (HRE) No. 2. The purpose of this exposure was to determine the effect of HRE-2 environment on mechanical properties and to provide corrosion data. Specimens were exposed in the low-flux core region and in two blanket loadings. While the specimens were in the low-flux core region, a maximum estimated fast (>1 Mev) neutron dose of 0.8×10^{18} nvt was accumulated. The calculated doses in the first and second blanket loadings were 1.3×10^{17} and 2.6×10^{18} nvt, respectively. Only insignificant changes were observed in the mechanical properties as a result of the smallest exposure (i.e., 0.8×10^{18} nvt). At 1.3×10^{17} nvt, some small decreases in ductility for Zircaloy-2, type 347 stainless steel, and A-40 titanium were observed. At 2.6×10^{18} nvt, small but definite changes in some of the mechanical properties were observed in all of the materials exposed, usually as small increases in the tensile and yield strengths and slight reduction in elongation, with the greatest changes occurring in the A-40 titanium. Negligible corrosion was observed during the three exposures. (auth)

33520 (PAN-309/XVII) INFLUENCE OF γ-RADIATION ON MECHANICAL PROPERTIES OF VULCANIZED RUBBER CORD COMPOUND. Wacław Zieliński (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Mar. 1962. 7p.

The use of gamma radiation in the process of whole-tire-reclamation was investigated. Data are included concerning radiation effects on rubber. (J.R.D.)

33521 (PAN-322/I-B) X-RAY OBSERVATION OF CHANGES IN THE MOSAIC STRUCTURE OF Al-SINGLE CRYSTALS UNDER FAST NEUTRON BOMBARDMENT. Zofia Szmid and Stanisław Szarras (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). May 1962. 15p.

The mosaic structure of three samples of Al-single crystals was studied before and after fast neutron bombardment. A change in the mosaic structure according to the dose of the neutrons was ascertained. Some displacements of the individual mosaic blocks after fast neutron bombardment were observed. (auth)

33522 (REIC-24) RADIATION EFFECTS STATE OF THE ART, 1961-1962. (Battelle Memorial Inst. Radiation Effects Information Center, Columbus, Ohio). June 30, 1962. Contract AF 33(616)-7375. 96p.

The effects of radiation on various materials, components, and systems are being studied. Topics covered include: electronic components and equipment, semiconductor devices and materials, polymeric materials, fuels, lubricants and hydraulic fluids, structural materials and alloys, ceramics, space environment, and dosimetry. (M.C.G.)

33523 (TID-16694) EFFECTS OF HIGH DENSITY IONIZING RADIATION ON COLLOIDAL SYSTEMS AND SUSPENSIONS. Quarterly Technical Status Report No. 1, March 1, 1962–May 30, 1962. Werner N. Grune, Walter H. Burrows, and Clyde Orr, Jr. (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). June 22, 1962. Contract AT(38-1)-202. 21p.

Facilities and methods for the experimental determination of electrophoretic mobility, conductivity and turbidity of solid-liquid systems have been acquired and are undergoing testing. Experimental studies of the effects of x-radiation on aerosols are in progress. Particle size distributions are being measured with and without radiation exposure. Radiation and particle size measurements are used to determine the effect of x-rays on aerosol formation and concentration decay. The first system selected for study was a vapor phase mixture of methyl methacrylate and nitrogen. To produce stable foams by dissolving gas under pressure in liquid systems, then releasing the system to atmospheric pressure, considerable experimentation with two different sizes of pressure bombs was carried out. A uniform foam was produced which required 90 minutes to drain and which appears to be satisfactory for radiation effects studies. A standard system of emulsifying and stabilizing agents for mineral oil emulsions has been adopted based on definite criteria. Preliminary studies of the characteristics of settling, and the rates of settling of diluted aliquots of the "Standard Emulsion" indicate the importance of pH. Relative settling rates were

observed by comparative nephelometry and particle size distributions obtained with a phase contrast microscope. (auth)

33524 (WAPD-263) EFFECTS OF HIGH BURNUP ON ZIRCALOY-CLAD BULK UO_2, PLATE FUEL ELEMENT SAMPLES. R. C. Daniel, M. L. Bleiberg, H. B. Meieran, and W. Yeniscavich (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Sept. 1962. Contract AT(11-1)-Gen-14. 290p.

The results of irradiation testing of Zircaloy-clad, UO_2 plate fuel element samples demonstrated the applicability of this configuration to extended in-pile service and have shown that the factors most important in limiting the useful in-pile life of bulk UO_2 plate-type elements are in-pile operating temperature, fuel restraint, and fuel density. It was shown that the amount of fission gas released from the UO_2 is increased when the fuel is subjected to excessive operating temperatures and high exposure. Microstructural changes in bulk UO_2, consisting primarily of the precipitation of both nonvolatile and volatile fission products, were noted at high exposure and high temperature, but no change in the UO_2 crystal lattice was observed. The excellent out-of-pile corrosion resistance of Zircaloy cladding was confirmed in in-pile loop tests of these samples, although, under abnormal conditions involving intentional clad defects, high coolant activity can result from corrosion of the UO_2 fuel, and accelerated corrosion of the cladding can occur. (auth)

33525 (AEC-tr-5365) ANALOGY IN RADIATION EFFECTS ON SOLIDS OF NUCLEAR RADIATION AND SLOW CHARGED PARTICLE FLUXES. (Analogii v Radiatsionnom Deistvii na Tverdye Tela Yadernykh Izluchenii i Potokov Medlennykh Zaryazhennykh Chastits). S. V. Starodubtsev. Translated from IAEA preprint No. SM-25/75 presented at the Symposium on Radiation Damages in Solids and Reactor Materials, Venice, May 7-11, 1962. 13p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, as abstract no. 22702.

33526 (AEC-tr-5387) GAMMA RADIATION FROM NEUTRON-INDUCED GROUND ACTIVITY FOR A GIVEN BOMB COMPOSITION, EXPLOSION ALTITUDE AND GROUND ANALYSIS. (Gammastrålning från Neutron-inducerad Markaktivitet vid Given Bombsammansättning, Explosionshöjd och Markanalys). M. Leimdoerfer (Sweden. Försvarets Forskningsanstalt, Stockholm). Translated for Oak Ridge National Lab., Tenn. Mar. 1962. 6p.

A method for determining neutron-induced activity in the ground is described. Results from a test are included along with the description of a bomb composition from which the neutrons are assumed to originate. (J.R.D.)

33527 (UCRL-Trans-857(L)) CHARACTERISTICS OF GAMMA-LUMINESCENCE OF PHOSPHORS. V. V. Antonov-Romanovskii. Translated by Sergey Shewchuck (Univ. of California Lawrence Radiation Lab., Berkeley) from Zhur. Eksptl'. i Teoret. Fiz., 21: 269-74(1951). 16p.

The attenuation curve obtained with the phosphor ZnS-Pb, Cu in gamma-excitation is compared with the attenuation curves for photoexcitation. It is concluded that the ionized centers of lumination and the additional electrons originate along the paths of high-energy electrons generated by the gamma radiation in the phosphor material. In such structures, the regions occupied by the electrons greatly exceed the regions occupied by the ionized centers. (J.R.D.)

33528 THE EFFECT OF THE TEMPERATURE AND OF THE MICROSTRUCTURE OF SINTERED BERYLLIUM OXIDE ON THE THERMAL NEUTRON SCATTERING CROSS SECTION. I. F. Zhezherun, I. P. Sadikov, and A. A. Chernyshov. At. Energ. (USSR), 13: 250-7(Sept. 1962). (In Russian)

One of the chief causes affecting the temperature coefficient of the reactivity of BeO-moderated reactors is the change of the effective scattering cross section together with the related temperature-related changes of the diffusion length of thermal neutrons. In view of the difficulties involved in the computation of these values, the changes of the scattering cross section of BeO as a function of temperature were determined experimentally; an attempt was also made to establish whether the sintered oxide presents any anisotropy that may have to be taken into account in reactor calculations. A mechanical neutron selector, installed in the horizontal beamhole of the RFT reactor, was used for the tests; the system which included the time analyzer allowed a resolution of 4 to 10% in the 0.003 to 0.1 ev range, was calibrated by the resonance absorption of Cd. The total effective cross section σ_t of the specimens was determined at 290, 800, 1300, and 1500°K. The σ_t value of BeO specimens having various microstructures was determined at room temperature. It was found that variations in the texture cause only a slight anisotropy of the scattering but the crystalline grain size influenced σ_t more markedly. It is concluded that the grain size should not exceed 10 microns in order to maintain the scattering cross section at its highest value. (TTT)

33529 EFFECT OF INITIAL STRAINING AND γ IRRADIATION ON STRENGTH OF POLYETHYLENE. C. C. Hsiao and J. W. Yang (Univ. of Minnesota, Minneapolis). J. Appl. Phys., 33: 2870-2(Sept. 1962).

Uniaxially and biaxially oriented samples of polyethylene irradiated by γ rays are investigated at room temperature. Both the tensile strength and the modulus of elasticity are found to increase as the degree of orientation induced by homogeneous deformation increases. The tensile strength, however, decreases as the γ dose increases, while the modulus of elasticity increases as the γ dose increases. The combined effects seem to indicate that γ irradiation essentially destroys the macromolecular orientation and thus reduces the tensile strength to that of unoriented solid, but produces a relatively higher elastic modulus as a result of crosslinking. (auth)

33530 DEFECT STRUCTURES OBSERVED IN NEUTRON-BOMBARDED ALUMINUM. T. K. Bierlein and B. Mastel (General Electric Co., Richland, Wash.). J. Appl. Phys., 33: 2873-5(Sept. 1962). (HW-SA-2496)

Aluminum irradiated at approximately 60°C by neutrons is examined by transmission electron microscopy. Small dislocation loops and larger dislocation rings form during an exposure of 3×10^{18} nvt (E > 1 Mev) and increase in number with increasing irradiation dose. It is suggested that the small loops are prismatic loops, which arise from the clustering and subsequent collapse of vacancies produced by neutron bombardment. Dislocations that encounter prismatic loops frequently form rings about the loops or other obstacles. (auth)

33531 EFFECT OF BOMBARDMENT OF TITANIUM BY ENERGETIC DEUTERIUM IONS. O. C. Yonts and R. A. Strehlow (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 33: 2903-4(Sept. 1962).

Ti targets are bombarded by D^+ and D_2^+ ions at 10 to 35 kev, up to total fluxes of about 1.7×10^{21} particles. No sputtering is observed, and much of the mass carried by the

incident beams is accounted for by weight increases in the targets. The formation of TiD_2 on the target surfaces is observed, and the diffusion of deuterium ions into Ti is discussed. (T.F.H.)

33532 LATTICE DEFECT PRODUCTION IN THERMAL NEUTRON SHIELDED MATERIALS. J. W. Cleland, R. F. Buna, and J. H. Crawford, Jr. (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 33: 2906(Sept. 1962).

It is noted that in reactor irradiation procedures using a thermal neutron shield, capture gamma rays produced in the shield may have an appreciable effect on the material on which the irradiation is being carried out. The capture gamma spectrum of Cd is discussed as an example, and the gamma-produced damage to Al and Cu is outlined for gamma energies of 1 to 5 Mev. In an attempt to ascertain the mechanism for production of lattice defects by gamma radiation, the damage produced in Ge and Si by gamma radiation at 0 to 5 Mev and by thermal neutrons is compared. (T.F.H.)

33533 ELECTRIC CHARACTERISTICS OF GAMMA-RAY IRRADIATED SHIELDING WINDOW GLASS. Kakuji Yamamoto and Masao Tsuchiya (Tokyo Metropolitan Isotope Center). J. Appl. Phys., 33: 3016-20(Oct. 1962).

Induced color of shielding window glass of various kinds by γ irradiation is studied. With a 1-kC Co^{60} radiation source, 23° ± 3°C as irradiation temperature, 10^5 r/h as exposure dose rate, and 10^5 to 10^7 r as total exposure dose, the coloration increases gradually. Volume resistivity of glass and its change by gamma irradiation are measured. 100 v d-c is applied to a sheet of glass sandwiched between two electrodes to measure the change of its electric resistance with time. The quantity of induced space charge by radiation is calculated by time integration of the current obtained from reciprocal of the resistance. Resistance of high density glass is found to become a minimum at a dose of 10^6 r, and to increase as the dose increases. Resistance of medium density glass decreases gradually. Change of the resistance is exponential and the charge is always positive at any dose. This result testifies that glass is electrified by radiation. Linearity is established between the quantity of space charge and the dose in a range of 10^5 to 4×10^5 r. (auth)

33534 DISLOCATION LOOPS IN FISSION FRAGMENT BOMBARDED LEAD IODIDE. Lewis T. Chadderton (Cavendish Lab., Cambridge, Eng.). J. Appl. Phys., 33: 3021-26(Oct. 1962).

Bombardment of thin crystals of lead iodide with uranium fission fragments does not produce distinct linear tracks but randomly distributed dislocation loops inclined to the surface of the crystals. These loops are formed by the aggregation of highly mobile point defects. Further point defects are produced by high-intensity electron beams and the original loops are observed to move and grow, and eventually to coalesce. (auth)

33535 RADIATION INDUCED HUMP STRUCTURE IN THE I-V CHARACTERISTICS OF ESAKI DIODES. C. B. Pierce, H. H. Sander, and A. D. Kantz (Sandia Lab., Albuquerque, N. Mex.). J. Appl. Phys., 33: 3108-18(Oct. 1962). (TID-15456)

Well-defined hump structure is produced in the excess current region of Si, Ge, and GaAs Esaki diodes by irradiation with 2-Mev electrons, when the I-V characteristic is observed at low temperature. Si diodes develop humps at 0.35, 0.63, and 0.90 v at irradiation temperatures from 77 to 300°K. Ge diodes show humps at 0.23 and 0.51 v when irradiated at low temperature, but only a hump at 0.23 v after room temperature irradiation. GaAs diodes show humps at approximately 0.4 and 0.9 v. Diodes of approximately one ma peak current generally show hump current changes comparable to the peak current with an integrated flux of approximately 10^{17} electrons/cm^2. On the basis of a simple model postulating direct tunneling of electrons from the conduction band of the n material to defect levels in the p material, defect levels in Ge and Si are located. The first two humps in Si anneal from slightly above room temperature to above 250°C. The third hump does not anneal significantly to 250°C. The two humps produced on low temperature irradiation of Ge anneal rapidly just below 0°C, while a third hump at 0.60 v appears in this temperature range. Hump structure produced or remaining in Ge at room temperature is stable to above 100°C, where annealing takes place with second-order kinetics and apparently goes to completion. (auth)

33536 INFLUENCE OF IRRADIATION ON CREEP. D. Mosedale (United Kingdom Atomic Energy Authority, Dounreay, Caithness, Scotland). J. Appl. Phys., 33: 3142-3(Oct. 1962).

It is predicted that the expression $\dot{\epsilon}_f = \dot{\epsilon}_0 (1 + Kf)$ for creep in fcc metals, which is based on the theory of climb-controlled creep, is incorrect. In this expression, $\dot{\epsilon}_f$ and $\dot{\epsilon}_0$ are the time derivatives of the creep rates in the presence of fast neutron fluxes of f and 0 cm^{-2} sec^{-1} respectively, and K is a constant for a given metal. It is also predicted that irradiation should not affect climb-controlled creep. (T.F.H.)

33537 THE EFFECTS OF γ-IRRADIATION ON POLYMETHYL METHACRYLATE. Naoyuki Kishi and Kazumasa Kamata. J. Appl. Phys. (Japan), 30: 411-16(June 1961).

Radiation effects on the decrease in the molecular weight of stressed and unstressed polymethyl methacrylate was the same for both. The mechanical properties of PMMA depreciated rapidly when the irradiation dosage exceeded 3×10^5 r and the degree of polymerization fell below 1500. The glass transition temperature, T_g, of irradiated PMMA decreased with increasing dosage. The relationship between T_g and the molecular weight, M_v can be expressed as $1/T_g = 2.85 \times 10^{-3} + 0.333 \times 10^4 \times 1/M_v(1/K)$. The G-value for the main chain fracture of samples irradiated in a vacuum and in air was about 2.1. PMMA irradiated with a dosage of $10^7 \sim 10^8$ r became swollen with bubbles when heated even after 2 yr and 2 mo of storage at room temperature. The swelling seemed to be attributed to the generation of gas, not only during irradiation but also during heating. (OID)

33538 THERMAL GLOW LUMINESCENCE IN PLASTICALLY DEFORMED KCl CRYSTAL IRRADIATED BY X-RAY AND ULTRA VIOLET LIGHT. Masayasu Ueta, Hiroshi Sugimoto, and Ikuo Nagasawa (Tohoku Univ., Sendai). J. Phys. Soc. Japan, 17: 1465-73(Sept. 1962). (In English)

Thermal glow luminescence in plastically deformed KCl crystals is studied experimentally. The thermal glow curves become simple and similar irrespective of the origin of crystals, in contrast with the case of "as-cleaved" crystals. In the case of ultraviolet illumination at room temperature, glow curves consist of four peaks, at 80, 160, 200, and 250°C. The intensity of glow peaks increases with deformation. The observed glows are attributed to the interaction of excitons with vacancy clusters. In x-rayed crystals, three peaks appear, at 80, 140, and 250°C. The peak at 250°C is outstanding and is considered to be luminescence resulting from the recombination of F and V_3 centers. Glows at 80 and 140°C are attributed to the recombination of electrons released from N and M centers with trapped holes in V_2 centers. The recombination proba-

bility of 250°C glow is enhanced by the perturbed field caused by the plastic deformation. (auth)

33539 γ RAY IRRADIATION EFFECT ON THERMALLY OXIDIZED Si P–N JUNCTION. Hiroshi Edagawa (Kobe Kogyo Corp., Kobe, Japan), Hajime Ishikawa, Yoshinori Morita, and Yoshio Inuishi. J. Phys. Soc. Japan, 17: 1521-2(Sept. 1962). (In English)

The effects of gamma irradiation and thermal annealing on the photoresponse and reverse electric properties of p-n^+ and p^+-n Si junctions are studied. The junctions are prepared by thermal oxidation of Si in water vapor. The activation energy of the annealing process is calculated as 1.5 ev. (T.F.H.)

33540 METALLURGICAL ASPECTS OF FIVE YEARS EXPERIENCE ON THE RADIATION OF URANIUM–MAGNOX FUEL ELEMENTS. V. W. Eldred. Met. ital., 54: 256-260(July 1962). (In Italian)

The results of five years' experience on the behavior of Uranium–Magnox fuel elements, subjected to radiation in Calder and Chapelcross (England) reactors are described. The examined fuel elements were mostly of common production; however, a considerable number of experimental fuel elements or incorporated in a new material or newly shaped are examined. The results which confirmed the present design and those which led to modify either the components or the design are illustrated. (auth)

33541 RADIATION BRITTLENESS OF FERRITIC MATERIALS. J. Spreadborough (Battelle Memorial Inst., Geneva). Met. ital., 54: 272-6(July 1962). (In Italian)

The importance of the brittleness due to radiation in ferritic materials is pointed out. Owing to neutron radiation impact the transition temperature can rise from ductile to brittle in steels up to the point of provoking dangerous radiation cracks. Although the general conclusions from experimental data agree with the theory, it is not possible to explain the behavior of a ferritic material since the effects of the metallurgical variables (grain size excluded) are not determined and are not correlated with transition temperature variations due to neutron radiations. Further work should be directed to know these effects and the mechanics of radiation brittleness. To this purpose radiation conditions must be carefully controlled, besides dosimetry, and self-shielding, in designing the radiation tests, must be pointed out. (auth)

33542 RESULTS OF GAMMA IRRADIATION OF RADIOTECHNICAL PARTS. Sh. M. Gazyev and G. Aripov. Nektorye Voprosy Prikiad. Fiz., 49-50(1961).

The fact that the mechanical and electrical properties of materials and parts used in radio engineering can be modified by gamma irradiation was utilized to study the behavior of radio sets in radiation fields and to develop radioresistant sets. A series of resistors were irradiated with gamma rays, one low-ohmic and one high-ohmic resistor of the same type in each experiment. The parameters were measured before and after gamma irradiation in a pit at a dose rate of $1 \times 0.1 \times 60$ g, 650 rep/sec before and after gamma irradiation. The initial integral dose amounting to 100×10^6 rep was increased to 1100×10^6 rep in intervals of 100×10^6 rep. Measurements showed that the conductivity of all the low-ohmic resistors remained constant even at the maximum integral dose. The conductivity of high-ohmic resistors with a very thin conductive layer was, however, changed. As the radiation dose is increased, the resistance of the various types increases by 25 and 3%. (OTS)

33543 INFLUENCE OF FOREIGN SOLUTE ATOMS ON STAGE I RECOVERY IN ELECTRON-IRRADIATED COPPER. A. Sosin and H. H. Neely (Atomics International, Canoga Park, Calif.). Phys. Rev., 127: 1465-70(Sept. 1, 1962).

Additions of 0.1 at. % Be, 0.1 at. % Ag, and 0.03, 0.1, 0.3 and 1.0 at. % Au in copper are observed to suppress recovery of electrical resistivity below 60°K following electron irradiation. The effects of Ag and Au are essentially the same; Be is considerably more effective in suppressing recovery. The effects of composition of Au are evaluated. It appears that close-pair recombination is accomplished with only one or two jumps, on the average, and that other recovery processes involve appreciably more jumps. The number of potential trapping sites associated with each impurity atom appears to be over 30 and may approach 100. (auth)

33544 ANNEALING OF ELECTRON-IRRADIATED GaAs. L. W. Aukerman and R. D. Graft (Battelle Memorial Inst., Columbus, Ohio). Phys. Rev., 127: 1576-83 (Sept. 1, 1962).

The annealing behavior of n-type GaAs irradiated at room temperature with 1-Mev electrons is investigated. The fraction f of the defects remaining after annealing for a time t at an elevated temperature decays according to the relationship $f = a \exp(-\lambda_1 t) + (1 - a) \exp(-\lambda_2 t)$. The rate constants λ_1 for various specimens annealed at different temperatures obey the Arrhenius relationship, giving an activation energy of 1.1 ± 0.5 ev. λ_1 appears to be an intrinsic property of n-type GaAs. λ_2, on the other hand, is dependent on the carrier density, i.e., the annealing is influenced by the position of the Fermi level. The recovery of p-type specimens is qualitatively different than that of n type. Some results concerning the effect of irradiation on electrical properties are also included. (auth)

33545 THE EFFECTS OF RADIATION ON HIGH POLYMERS. POLYETHYLENE, POLYPROPYLENE AND POLYOXYMETHYLENE. Kazuo Manaka. Toshiba Rev. (Japan), 16: 161-8(Feb, 1961).

Polyethylene, polypropylene, and polyoxymethylene were irradiated with either Co^{60} γ rays or β rays from an accelerator in air and in vacuum. The irradiation effects were examined by measuring the flow characteristics, and analyzing their nuclear magnetic resonance absorption, infrared absorption, and carbon-hydrogen contents. The flow curves of polymers showed the degree of cross-linking and scission with fair accuracy. The nuclear magnetic resonance absorption, infrared absorption, and the H and C content were in good agreement with the flow curves in determining the effect of irradiation. A comparison of effects of the irradiation between the polymers showed differences in general characteristics among them clearly. (OID)

33546 REACTOR STRUCTURAL MATERIALS: ENGINEERING PROPERTIES AS AFFECTED BY NUCLEAR REACTOR SERVICE. W. K. Anderson, C. J. Beck, A. B. Kephart, and J. S. Theilacker (American Society for Testing and Materials, Philadelphia). ASTM Special Technical Publication No. 314. 98p. $4.50.

Data are reviewed and given for the radiation effects on iron, carbon steel, and stainless steel; nickel and cobalt alloys; aluminum and titanium; and zirconium alloys. The properties studied include physical, mechanical, and chemical properties, with the emphasis on the mechanical properties. (D.L.C.)

33547 RADIATION DAMAGE IN SOLIDS. VOL. I. Part of the Proceedings of the Symposium on Radiation Damage in Solids and Reactor Materials Held at Venice, May 7-11, 1962. (International Atomic Energy Agency, Vienna). Proceedings Series. July 1962. 392p. (STI/PUB/50). $7.00; 147s; NF 28; DM 24.50(IAEA).

A total of 20 papers is included, for 16 of which separate

abstracts were prepared. The other papers, which were previously abstracted in Nuclear Science Abstracts, are on analogies between the radiation effects on solids caused by nuclear radiation and fluxes of slow charged particles in solids, the nature of radiation damage in metals, the energy dependence of electron damage in pure and doped Cu, and the recovery of radiation damage in Mo. (J.R.D.)

33548 THE RANGES OF ENERGETIC ATOMS IN SOLIDS. D. K. Holmes (Oak Ridge National Lab., Tenn.). p.3-42 of "Radiation Damage in Solids. Vol. I." Vienna, International Atomic Energy Agency, 1962. (In English)

One of the important problems of radiation damage is that of determining the spatial extent of the damaged region, particularly in the case of heavy-particle damage, and specifically for investigations involving reactor bombardments, in the case of fast neutrons. Within the past three years some important results were published in which the ranges of atoms (with energies up to a few hundred kev) in solid materials were given. Knowledge of the range of one atom does not, of course, give the full details of the extent of the damaged region involving the cascade of displaced atoms resulting from the primary; however, the range of the primary is in most cases a good measure of the extent of the damage. A further difficulty is that as the primary slows down, not only is the behavior of the interatomic potential important, but at the low-energy end of the process (around 100 ev and lower) lattice effects, such as focusing, may lead to additional spread of the total damage, which is greater than that of the primary itself. Fortunately, the experimental results apply especially to the movements of primaries. Experimental results are used to obtain more information about the interatomic potential in this energy range. Two approaches to the problem are considered, the analytical and the Monte Carlo. The analytical work is mostly based on the "hard-sphere approximation" to interatomic collisions, which, however, does permit some testing of interatomic potentials through the choice of the hard-sphere radius. Because of the analytical simplicity of this model it is possible to calculate various average quantities which can be related to the range (such as $\overline{r^2}$) and features of the final distribution function itself. In the Monte Carlo calculations the histories of individual primaries are followed to completion, leading directly to final distribution functions and appropriately chosen averages. These calculations (using an IBM 7090 computer) are designed to give a wide latitude in the choice of interatomic potential, and thus allow immediately an evaluation of the validity of the hard-sphere approximation. The results of both of these methods are compared with experiment. (auth)

33549 KNOCK-ON CASCADES AND POINT-DEFECT CONFIGURATIONS IN BINARY MATERIALS. J. R. Beeler, Jr. and D. G. Besco (General Electric Co., Cincinnati). p.43-63 of "Radiation Damage in Solids. Vol. I." Vienna, International Atomic Energy Agency, 1962. (ORO-547). (In English)

Characteristics of radiation damage in binary material subjected to heavy atom bombardment were studied in a two-dimensional calculation employing the hard-sphere approximation and the Bohr screened potential. A square planar lattice of Be and O atoms was subjected to I_2 and Kr primary atom bombardment at 1 to 50 kev. About two-thirds of all vacancies produced were members of clusters containing three or more vacancies. Disordering by replacement collisions was extensive. Given a type of atom, the number of vacancies for this atom type was not equal to the number of interstitial atoms of the same type because of numerous replacement collisions. Penetration of primary atoms was highly sensitive to the angle of incidence. For incident directions oriented between 15 to 35° to a principal lattice direction, penetration was proportional to the 0.44 power of the incident energy. At other incident angles the primary atom trajectory tended to focus between two lines of atoms. In these instances the penetration became proportional to the incident energy as the incident angle approached either zero or 45°. Krypton atoms penetrated about two-thirds the distance penetrated by I_2 atoms of the same energy. The computational model assumed produced displacement spikes in Cu if the energy of the primary Cu atom was 15 kev or greater. (auth)

33550 SHARING OF ENERGY DISSIPATION BETWEEN ELECTRONIC AND ATOMIC MOTION. J. Linhard and P. V. Thomsen (Univ. of Aarhus, Denmark). p.65-76 of "Radiation Damage in Solids. Vol. I." Vienna, International Atomic Energy Agency, 1962. (In English)

Integral equations are given for radiation effects, as functions of the incoming particle, the particle energy E and the medium. Also the significant fluctuations in radiation effects are described. As important examples, the energy given to recoil atoms, $\nu(E)$, and to electrons, $E - \nu(E)$, from which other radiation damage effects may be obtained is studied. Damage effects such as the number of dislodged atoms are normally proportional to $\nu(E)$. The description is based on the differential scattering cross-sections in an ion-atom collision and the stopping cross-section for electron excitation by an incoming ion. For these quantities we apply comprehensive formulas, derived in a Thomas-Fermi treatment. The basic case concerns an incoming particle having the same atomic number and mass as the atoms in the medium. For the basic case curves have been computed giving $\nu(E)$ and its fluctuations for any atomic number of the medium. It is desirable that the basic case be investigated experimentally for various energies and atomic numbers. As an example of a secondary case, the effects of fission fragments in a light substance are discussed. (auth)

33551 ASSISTED FOCUSING COLLISIONS IN F.C.C. LATTICES AT SMALL ANGLES. R. Frère (Centre d'Étude l'Énergie Nucléaire, Brussels). p.87-98 of "Radiation Damage in Solids. Vol. I." Vienna, International Atomic Energy Agency, 1962. (In English)

The importance of geometrical factors in determining the nature of radiation damage in face-centred cubic metals for low-energy collisions was demonstrated by means of machine calculations. The focusing parameter is derived as a function of the energy. The model used is a so-called "delayed-hard-sphere model;" the scattering problem is solved classically by means of the impulse approximation. The agreement with the results is good for both [110] and [100] focusing chains. (auth)

33552 THE INFLUENCE OF NEUTRON IRRADIATION ON THE MECHANICAL PROPERTIES OF FACE-CENTRED CUBIC METAL CRYSTALS. Joerg Diehl (Max-Planck-Institut für Metallforschung, Stuttgart). p.129-54 of "Radiation Damage in Solids. Vol. I." Vienna, International Atomic Energy Agency, 1962. (In English)

The main features of radiation hardening caused by reactor irradiation of face-centred cubic metals, such as Cu were established by previous work. The most striking effect is the pronounced increase of the yield stress with increasing neutron dose. This can be explained by the formation of so-called depleted zones, which act as obstacles to the movement of dislocations. Studies of the mechanical behavior of neutron-irradiated metal crystals seem to be a valuable tool for the investigation of this type of radiation-induced defect and its interaction with dislocations. Most previous work was carried out with polycrystals, or, if

single crystals were used, the results are masked by a possible dependence on the crystallographic orientation of the crystals. Therefore, the dependence of the yield stress and the work-hardening behavior on the integrated neutron flux and on the deformation temperature was studied systematically with Cu and Ni single crystals of identical orientation. In addition, the effects of the crystal orientation was examined. At low doses ($nvt \lesssim 2 \times 10^{17}$ cm^{-2}) the yield stress increases proportionally to the square root of the neutron dose. At higher doses saturation effects become apparent. This can be attributed to the interaction of crowdions coming from one zone with neighboring zones. The work-hardening behavior at small and high doses shows characteristic differences. In the low-dose range, where the stress-strain curves show a strong resemblance to those of unirradiated crystals, the effects of the irradiation on the work-hardening parameters can be interpreted in terms of a superposition of a gradual destruction of the depleted zones and "normal" work-hardening. This apparently does not apply to more heavily irradiated crystals. Ni crystals behave qualitatively similarly to Cu. Some quantitative differences are discussed. (auth)

33553 PRESENT KNOWLEDGE OF POINT DEFECTS IN IRRADIATED F.C.C. METALS. R. O. Simmons, J. S. Koehler, and R. W. Balluffic (Univ. of Illinois, Urbana). p.155-204 of "Radiation Damage in Solids. Vol. I." Vienna, International Atomic Energy Agency, 1962. (In English)

Information about point defects in metals comes from theory, equilibrium experiments at temperatures near the melting point, quenching and annealing experiments, plastic deformation experiments, and studies of the production and thermal annealing of radiation damage. In the last few years theoretical studies indicated new types of defect and of interaction between defects which should be considered, and further indicated the great complexities which may be encountered in many experiments. Theory was able to give rough values for various defect properties. Accurate experimental values for lattice-vacancy-type defects in f.c.c. metals are now becoming available as a result of equilibrium and quenching measurements on high-purity materials. Recent work on the metals Cu, Ag, Au, Al, Pt, and others is summarized. There is satisfactory agreement between equilibrium measurements and quenching results for Ag, Au, and Al. Some information of a more qualitative nature was obtained from plastic deformation experiments. With the aid of this information a broad survey of radiation damage experiments is undertaken. An analysis of low-temperature radiation damage experiments, primarily on Cu, yields additional information about interstitial-type defects. Cu, and Ag are found to be closely similar in annealing characteristics, whereas Au is different in some respects. The monovacancy migration energy inferred from equilibrium experiments on Cu indicates that the assignment of atomic mechanisms for the annealing of Cu above 60°K needs to be re-examined. Available data for thermal annealing of the different f.c.c. metals after cold-work are compared with the annealing after radiation damage. In both cases extensive continuous spectrum annealing is present. No case of unambiguous identification of an atomic mechanism for annealing above 60°K in irradiated or cold-worked f.c.c. metals is found. (auth)

33554 SOME EFFECTS OF ELECTRON IRRADIATION ON THE INTERNAL FRICTION OF COPPER. Jenifer N. Lomer, E. W. J. Mitchell, and D. H. Niblett (Univ. of Reading, Berks, Eng.). p.205-22 of "Radiation Damage in Solids. Vol. I." Vienna, International Atomic Energy Agency, 1962. (In English)

The internal friction of a Cu strip of 99.999% purity was measured at about 0.5 kHz before and after electron irradiation at both room and liquid N_2 temperatures. Measurements were also made during warm-up. It was found that a small change exists at 100°K, only detectable after relatively high electron doses. A change occurs during warm-up, beginning at about 200°K, the precise temperature being variable. No effect was observed at 140°K. A further change was found beginning at about 265°K. For the room-temperature irradiations, the variation with dose and energy, was consistent with a displacement energy in the range 20–30 ev. (auth)

33555 AN INVESTIGATION OF THERMAL SPIKES IN GOLD BY OBSERVING THE ENERGY SPECTRUM OF SPUTTERED ATOMS. H. W. Thompson (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.239-48 of "Radiation Damage in Solids. Vol. I." Vienna, International Atomic Energy Agency, 1962. (In English)

Evidence from sputtering experiments is presented which indicates that a region of local heating surrounds an energetic recoil event. A comparison of the experimentally determined energy spectrum of sputtered atoms with those predicted theoretically from two alternative models shows that the radius of the region depends on the range of focused collision sequences rather than the energy of recoil. (auth)

33556 THE ENERGY DISTRIBUTIONS OF PRIMARY ATOMS IN COPPER PRODUCED BY FAST MONOENERGETIC AND REACTOR NEUTRONS. H. Wollenberger (Institut für Reaktorwerkstoffe, Kernforschungsanlage, Jülich, Ger.). p.249-58 of "Radiation Damage in Solids. Vol. I." Vienna, International Atomic Energy Agency, 1962. (In English)

Calculations based on the measured differential scattering cross-section are made for the energy distribution of primary atoms produced in Cu by neutron irradiation. Various neutron energies are considered with special attention to the neutron energies representative of a converter or of a Be gun and for the energy spectrum in hole 12 of the ORNL graphite reactor. The total cross-sections for the production of primary atoms are found to be 5.7 barns for the reactor spectrum, 2.9 barns for the 1.5-Mev neutrons, and 2.3 barns for the 3.7-Mev neutrons. The number of Frenkel pairs which should be produced in relation to the primary energy distributions obtained are estimated and compared with experimental data. (auth)

33557 THE EMBRITTLEMENT OF BODY-CENTERED CUBIC TRANSITION METALS BY NEUTRON IRRADIATION. A. A. Johnson, N. Milasin, and F. N. Zein (Imperial Coll. of Science and Tech., London). p.259-75 of "Radiation Damage in Solids. Vol. I." Vienna, International Atomic Energy Agency, 1962. (In English)

The hardening and embrittlement of pure body-centered cubic transition metals by neutron irradiation are discussed in the light of recent theories of the deformation and fracture of these metals. For relatively low doses ($<10^{19}$ nvt) the hardening is characterized by an increase in yield stress without a corresponding increase in ultimate tensile stength. This probably means that the hardening is caused almost entirely by the pinning of dislocations by point defects. Higher neutron doses give more complex effects which cannot yet be interpreted. The irradiation hardening is accompanied by an increase in the ductile-brittle transition temperatures, but the exact relation between these two effects is not yet clear. So far practically nothing is understood about the mechanisms of irradiation hardening and embrittlement in more complex b.c.c. structures such as ferritic steels. When certain b.c.c. metals, such as Nb, Mo, and W, are irradiated at near room temperature, a

species of point defect, believed to be the lattice vacancy, is retained in the lattice. The vacancies become mobile when the metal is heated to a suitable temperature, e.g., 150 to 200°C in the case of Mo, and are then annihilated by a variety of mechanisms. Some experiments are described in which some of the mechanical properties of Mo irradiated to a dose of 2×10^{18} nvt were measured before and after annealing out the retained vacancies. It was found that the annealing caused increases in the yield stress, the ductile-brittle transition temperature, and the temperature-dependence of the yield stress. These effects are believed to have resulted from the pinning of dislocations by vacancies which condensed onto them during the annealing treatment. (auth)

33558 EFFECT OF FAST-NEUTRON IRRADIATION ON THE MECHANICAL PROPERTIES OF PURE IRON. J. G. Y. Chow, S. B. McRickard, and D. H. Gurinsky (Brookhaven National Lab., Upton, N. Y.). p.277-98 of "Radiation Damage in Solids. Vol. I." Vienna, International Atomic Energy Agency, 1962. (BNL-6069). (In English)

The effect of fast-neutron (> 1 Mev) irradiation on the mechanical properties of pure Fe with grain diameters ranging from 0.016 mm to 0.11 mm were studied by the tensile test of special contoured specimens at 4 to 300°K. Yield stress, fracture stress, tensile stress, reduction of area and true stress-strain relations were determined on specimens irradiated to integrated fluxes of up to 10^{19} nvt. In addition, changes in hardness, micro-structure after deformation and electrical resistivity were determined. The effect of post-irradiation annealing on recovery of initial properties was investigated. The unirradiated yield stress data can be correlated with grain size as suggested by Petch and Hall; i.e., $\sigma_{ys} = \sigma_0 + K_y d^{-1/2}$. As found in other studies σ_0 and K_y were observed to increase with decreasing temperature. However, after irradiation, although σ_0 increased with decreasing temperature and increasing radiation dose, the slope, K_y, decreased substantially and approached zero at temperatures below 200°K. The curves for irradiated yield stress against temperature could be fitted by a relation of the form $\sigma_{ys} = \sigma_0 \ln (I/KT)$. These results disagree with previously reported investigations, notably those of Hull and Mogford on low-c steels. It is also noteworthy that after an irradiation of 10^{19} nvt the hardness values of all specimens were the same irrespective of the initial grain size. In addition to the effects of irradiation on the yield stress, a change in the shape of the true-stress true-strain curves at temperatures near 300°K was observed. After an irradiation of 10^{18} nvt the curves are linear and the slope is a function of the temperature only. The curves can, in general, be described by the relation $\sigma_\epsilon = \sigma_\eta + k\epsilon$. These data suggest the formation of a radiation-induced subgrain structure resulting from a dislocation arrangement. An explanation of the observed changes is presented in terms of dislocations. Increases of 60 to 70°K in the ductile-to-brittle transition temperature in tension were observed in all grain sizes (after 10^{18} nvt), the highest transition temperature occurring at 130°K. Tensile, hardness and electrical resistivity data indicate that the damage "threshold" occurs below 10^{17} nvt and saturation in pure Fe occurs above 10^{19} nvt. The post-irradiation recovery behavior of pure Fe in two grain sizes after 10^{18} nvt was also studied. Changes in the twinning behavior at low temperatures are also presented. (auth)

33559 THE EFFECTS OF NEUTRON IRRADIATION ON PURE IRON. P. Moser and D. Dautreppe (Centre d'Etudes Nucléaires, Grenoble, France). p.299-307 of "Radiation Damage in Solids. Vol. I." Vienna, International Atomic Energy Agency, 1962. (In French)

Certain defects formed in pure Fe by fast-neutron irradiation are capable of re-orientation with respect to the local magnetization. They then produce a magnetic drag effect, the magnitude of which increases with the density of the defects. This drag effect appears as a decrease in the initial permeability as measured after demagnetization. The effect can only be observed in the temperature range where the mean jump time of the defect $\tau = \tau_0 \exp[W/kT]$ (where W = activation energy of motion) is of the same order as the observation times (e.g. from 1 min to about 1 hr). This temperature zone may be termed a "drag band," by study of which the value of W can be determined. Since the amplitude of the decrease is related to the density of the defects, the latter can be followed during annealing. After bombarding pure Fe at 78°K drag bands such as BT_1; very strong (in drag amplitude); situated near 100°K and corresponding to defects having an activation energy of 0.3 ev; BT_2; less strong; situated near 190°K, with W≈0.6 ev; and BT_3; smaller; situated near −10°C, with W≈0.7 ev were distinguished. Isochronous annealing operations revealed that BT, while being displaced in the higher temperature direction, split into two bands, BT_{1A}(100°K) and BT_{1B}(130°K). With C_{1A} and C_{1B} representing the defect densities responsible for these two sub-bands, it was observed that during annealing C_{1A} at first decreases, then increases and finally decreases to zero; C_{1B}, on the other hand, first increases, then passes through a maximum and subsequently decreases. After annealing up to 400°C, a band forms near 100°C, certainly corresponding to complex defects. New defects formed during annealing are thus indicated, and an explanation of the mechanism involved is proposed. After bombardment at 30°C there is a large band near 100°C, produced by defects whose activation energy is of the order of 0.9 ev. (auth)

33560 IRRADIATION DAMAGE TO BERYLLIUM. E. D. Hyam and G. Sumner (Reactor Development Lab., Windscale, Cumberland, Eng. and Reactor Fuel Element Lab., Springfields, Lancs, Eng.). p.323-332 of "Radiation Damage in Solids. Vol. I." Vienna, International Atomic Energy Agency, 1962. (In English)

The presence of gas bubbles at grain boundaries modifies the behavior of irradiated materials under stress at elevated temperatures, with a marked reduction in ductility and a distinct change in the mechanism of failure. These effects are described in detail for the case of Be, with particular emphasis on the microstructural changes observed at grain boundaries. The observations are consistent with the nucleation of grain-boundary voids by the gas bubbles and their subsequent growth by vacancy diffusion under intergranular stress. Theoretical considerations indicate that any stress will make a grain-boundary bubble grow to some extent, but that under a stress greater than a critical value, determined by the initial size of the bubble, the bubble will continue to grow as long as the stress is applied. Further, once the bubble has grown by more than 73% under this stress, the stress required to keep it growing becomes progressively less. (auth)

33561 ELECTRON MICROSCOPIC INVESTIGATION OF URANIUM FISSION. N. F. Pravdyuk and V. M. Golyanov (Order of Lennin Inst. of Nuclear Energy, Moscow). p.333-50 of "Radiation Damage in Solids. Vol. I." Vienna, International Atomic Energy Agency, 1962. (In Russian)

A method, based on the phenomenon of cathode sputtering in metals, was developed for preparing high-resolution (~10A) electron-microscopic samples. An investigation was made with a high-resolution (up to 7A) electron microscope of the interaction of the U^{235} fission fragments with these samples. It was found that, in samples with a grain-

size of less than 40 A, the fission fragments form hollow channels of 20 to 200 A diameter, which last a long time. The channels do not remain in crystal samples with a grain-size of more than 100 A, but "self-heal" by collective re-arrangement of the atoms. (auth)

33562 RADIATION-INDUCED DIFFUSION IN METALS. R. Sizmann and U. Daeunert (Technische Hochschule, Munich). p.351-62 of "Radiation Damage in Solids. Vol. I." Vienna, International Atomic Energy Agency, 1962. (In English)

The irradiation of a metal with heavy energetic particles generates within the lattice appreciable amounts of interstitial atoms and vacancies (Frenkel defects). At medium temperatures the interstitials are mobile and most of the Frenkel defects simply recombine. But a small fraction of the diffusing interstitials has a chance to escape recombining with vacancies by diffusing to other nearby sinks, such as dislocations, grain boundaries or outer surfaces of the specimen. Hence a high concentration of vacancies is expected near such sinks, giving rise to enhanced diffusion. The effects of radiation-induced diffusion at the surface of a metal crystal can be easily seen on electron micrographs: an originally rough metal surface (roughness steps of about 1000 Å) is strikingly smoothed after irradiation with about 3×10^{16} alpha-particles (5.3 Mev)/cm^2. (This dose is approximately equivalent to an irradiation with 2×10^{19} fast neutrons/cm^2). On Cu, the dependence of the smoothing effect on irradiation dose and surface structure is studied quantitatively. The radiation-induced diffusion will be of importance to structural properties of materials exposed to heavy-particle radiation, such as canning metals and fuels. (auth)

33563 ELECTRON-MICROSCOPE STUDY OF IRRADIATED PLATINUM. E. Ruedl, P. Delavignette, and S. Amelinckx (Centre d'Étude de l'Énergie Nucléaire, Brussels). p.363-84 of "Radiation Damage in Solids. Vol. I." Vienna, International Atomic Energy Agency, 1962. (In English)

Thin beaten foils of Pt were investigated by means of transmission electron microscopy. Foils, both as annealed and annealed and irradiated with fission fragments and α-particles, were examined. The annealed foils show features which are typical for a face-centred-cubic metal with a medium-high stacking fault energy. Prismatic loops, with an a/2 [110] Burger's vector, result from the irradiation; this could be proved by observing their motion. The loops anneal out at the temperature where, according to Piercy, vacancies become mobile. Preferential loop formation is noticed at certain boundaries, in particular along coherent twin boundaries. This is regarded as evidence that correlated collision chains lead to preferential defect formation at these boundaries by "defocusing" of [110] focusons. It is noticed that, for small doses, dislocation loops are not distributed at random in the interior of the grains but show a tendency to be aligned. This is interpreted as resulting from loop nucleation along the path of a fission fragmept. After quenching, specimens contain both cavities and loops. The damage rate of quenched specimens seems to be larger than that of annealed ones; the loop concentration is less along a denuded zone parallel to boundaries and subboundaries. It is suggested that either the vacancy clusters left by quenching are nucleation sites for loops or that the vacancy clusters defocus focusons and hence increase the damage. It is shown that the loops that are left after irradiation are presumably vacancy loops. (auth)

33564 RADIATION DAMAGE IN SOLIDS. VOL. II. Part of the Proceedings of the Symposium on Radiation Damage in Solids and Reactor Materials Held at Venice, May 7-11, 1962. (International Atomic Energy Agency, Vienna). Proceedings Series. July 1962. 292p. (STI/PUB/56(Vol.II)). $6.00; 126s; NF 24; DM 21(IAEA)

A total of 15 papers is included for 11 of which separate abstracts were prepared. Four papers were previously abstracted in NSA and are concerned with effects of neutron irradiation on non-fissionable alloys, radiation damage in Zr, Zircaloy-2 and stainless steel, analysis of engineering and basic research aspects of steel embrittlement by neutrons, and the use of Monte Carlo calculations in the analysis of radiation damage experiments. (J.R.D.)

33565 THE EFFECT OF NEUTRON IRRADIATION ON 50-50 Fe–Ni ALLOY. D. Dautreppe, J. Langier, J. Paulevé, and L. Néel (Centre d'Études Nucléaires, Grenoble, France). p.21-6 of "Radiation Damage in Solids. Vol. II." Vienna, International Atomic Energy Agency, 1962. (In French)

An Fe–Ni alloy (50-50) was neutron-irradiated in a magnetic field at different temperatures. Uni-axial magnetic anisotropy was produced in this way. The curves show that the in-pile production of anisotropic energy depends greatly on temperature. In particular, anisotropic energies of the order of 2×10^6 erg/cm^3 are obtained by bombarding at 300°C, while the order of magnitude is 2×10^4 erg/cm is obtained after bombardment at 30°C. This led to the assumption that there was an ordered structure of the AuCu type. Such a structure was shown to exist using x rays, which indicated the presence of characteristic superstructure bands. The ordered zones did not develop at random. The magnetic coupling of the bonds with magnetization influences the ordered state increase in crystallites which had a [100] or [110] axis close to the direction of magnetization. The development of the ordered state was confirmed by a marked drop in electric resistance under conditions of irradiation at 300°C. Irradiation yields a new FeNi ordered phase such as cannot be obtained by heat treatment because of the low critical temperature (in the region of 330°C). Fuller kinetic studies are being made using electric resistance, x rays and electron microscopy. Irradiated single crystals are now also being studied, with a view to determining the anisotropic energies of the new structure. Kinetic studies of annealing after irradiation at 30°C led to the measurement of an activation energy of 1.1 ev for the defects, a correct order of magnitude for vacancies. In addition, since the annealing kinetics of these vacancies are a very good second-order approximation, there is reason to think that they tend to form divacancies. (auth)

33566 THE EFFECTS OF IRRADIATION ON THE MECHANICAL PROPERTIES OF ZIRCALOY-2. J. Lemaire, J.-L. Bernard, E. Cibois, and M. Weisz (Centre d'Études Nucléaires, Saclay, France). p.27-53 of "Radiation Damage in Solids. Vol. II." Vienna, International Atomic Energy Agency, 1962. (In French)

Results of irradiation of Zircaloy-1 at 5×10^{17} and 1×10^{18} nvt fast flux, and 2×10^{20} and 8×10^{20} nvt thermal flux are presented. It was found that except in the case of work hardened metal, irradiation increases the breaking energy by an amount depending on the nature of the metal. Other results concerning tensile tests are included. Results of an annealing study are also included. (J.R.D.)

33567 THE EFFECT OF RADIATION ON DIFFUSION-CONTROLLED REACTIONS IN COOPER-BASE ALLOYS. M. S. Wechsler and R. H. Kernohan (Oak Ridge National Lab., Tenn.). p.81-103 of "Radiation Damage in Solids. Vol. II." Vienna, International Atomic Energy Agency, 1962. (In English)

A review is given of the work at the Oak Ridge National

Laboratory on the effects of radiation on ordering reactions in Cu-base alloys and the precipitation reaction in Ni–Be. These studies indicate that diffusion-controlled reactions in alloys are enhanced as a result of exposure to neutron, electron and gamma-ray bombardment. The conclusions to be drawn have a bearing on the use of structural materials in radiation environments, for they indicate the conditions under which irradiated alloys may be unstable. Also, results of the work suggest that the effect of a bombarding particle is greater at low fluxes. This result may be of importance in connection with radiation damage to structural materials, such as pressure vessels, exposed to low radiation fields. The electrical resistivity during neutron irradiation at 35°C was measured for binary Cu-base alpha-phase alloys containing solutes such as Al, Si, Zn, Ga, Ge, As, tin and Sb. The largest effects were observed for Cu–Al, and this alloy was studied in particular detail in the composition range near 15 at. % Al. Upon neutron, electron or gamma irradiation at 100°C, the resistivity of this alloy is observed to decrease by about 0.2 μΩcm. If the irradiation temperature is reduced to near liquid-N_2 temperature, no decrease in resistivity takes place, but upon warming the alloy above −50°C the decrease in resistivity sets in. The rate of the reaction was studied as a function of the intensity of the neutron or electron flux. It is found that the rate of reaction varies as the square root of the displacement production rate. Measurements are also described of the effect of neutron irradiation at 100°C on the specific volume, the x-ray diffuse-scattering and the specific heat of this alloy. These results are compared with earlier observations of the effect of neutron irradiation on the ordering reaction in Cu_3Au. The precipitation reaction in Ni–Be upon neutron irradiation was studied by means of Curie temperature, resistivity and hardness measurements. The status of the theory of radiation-enhanced diffusion is examined. (auth)

33568 NEUTRON-BOMBARDMENT-ENHANCED SEGREGATION IN Cu–Ni ALLOYS. A. Ascoli (Laboratori C.I.S.E., Milan). p.105-12 of "Radiation Damage in Solids. Vol. II." Vienna, International Atomic Energy Agency, 1962. (In English)

Electrical resistivity of neutron-irradiated Cu–Ni wires was measured against integrated flux. Relative decreases of resistivity as high as 4.3% were detected for a total integrated flux of about 1.7×10^{18} fast n cm^{-2} and no saturation limit was reached. The results can be explained in terms of segregation of the alloy. Some of them are rather erratic, especially in the high integrated flux region. The causes of this behavior are discussed. The relation of this experiment to previously reported magnetic measurements on the same irradiated alloy is also discussed. (auth)

33569 A STUDY OF NEUTRON-IRRADIATED-INDUCED EMBRITTLEMENT OF WELDABLE MANGANESE–MOLYBDENUM STEELS. J. Lemaire, E. Cibois, and M. Weiaz (Centre d'Études Nucléaires, Saclay, France). p.153-188 of "Radiation Damage in Solids. Vol. II." Vienna, International Atomic Energy Agency, 1962. (In French)

The fast neutron embrittlement of Mn–Mo steel by a flux of 2×10^{n} nv at 180°C was studied. The fast integrated flux was estimated to be about 5×10^{18} nvt. It was found that the increase Δt in the transition temperature and the increase in impact resistance are comparable with those indicated in the literature. (J.R.D.)

33570 MAGNETIC PROPERTIES OF IRRADIATED SA-212B PRESSURE-VESSEL STEEL. N. Balai and R. J. K. Hoech (Argonne National Lab., Ill.). p.191-203 of "Radiation Damage in Solids. Vol. II." Vienna, International Atomic Energy Agency, 1962. (TID-14165) (In English)

Magnetic properties of irradiation-hardened SA-212B pressure-vessel steel were measured and compared with unirradiated, hardened and tempered material from the same heat of steel. Dynamic magnetic characteristics were determined with an a-c compensated comparator bridge, at a frequency of 100 Hz and at low magnetic field strengths. The measurement of the coercive force was selected for the evaluation of static properties. The measurements revealed that the magnetic properties of the irradiated steel were not affected by the fast-neutron (>1 Mev) irradiation dosage at 1×20^{20} to 1.3×10^{21} nvt, although mechanical hardening takes place. These measurements revealed that irradiation damage cannot be traced by these techniques. The additional lattice distortions introduced by irradiation do not affect these magnetic properties. As-quenched, unirradiated SA-212B (water-quenched from 1450 to 1475°F) hardens to 48 to 50 R_C and progressively softens mechanically, and magnetically, with increasing tempering temperatures. Magnetic properties were found to be constant at 800°F to 1250°F. At the 1350°F tempering temperature the unirradiated steel softens appreciably, magnetically, but is still harder than fully annealed material. In this cross-rolled plate material, magnetic properties in the longitudinal and transverse directions were found to be identical by the two measurement methods used. (auth)

33571 REACTOR IRRADIATION STUDIES AT 4°K. R. R. Coltman (Oak Ridge National Lab., Tenn.). p.205-29 of "Radiation Damage in Solids. Vol. II." Vienna, International Atomic Energy Agency, 1962. (In English)

A He cryostat whose sample chamber is located near the center of the Oak Ridge Graphite Reactor is used for radiation damage studies at low temperatures. Sustained bombardment temperatures as low as 3.0°K were reached at full reactor power. The cryostat is maintained at bombardment temperatures using a closed-circuit He liquifier with a net heat capacity of 3 w in the sample chamber. The thermal- and fast-neutron fluxes at this facility are each 6×10^{11} nv, and the gamma heating is 3.5×10^{-9} w/g. Uninterrupted irradiations of up to 450 hr were made. Property changes in metals which were studied include electric resistivity, stored energy release, yield stress, and the independent effects of fast and thermal neutrons. The importance of such measurements in improving radiation damage understanding is discussed. (J.R.D.)

33572 A SINGLE-CRYSTAL X-RAY DIFFRACTION TECHNIQUE FOR THE STUDY OF RADIATION DAMAGE. E. Wait, M. J. Duck, A. C. Fox, E. E. Jackson, and A. R. Junkison (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.231-8 of "Radiation Damage in Solids. Vol. II." Vienna, International Atomic Energy Agency, 1962. (In English)

A technique for the investigation of highly radioactive material and its application to the study of radiation damage in fissile material is described. The method depends on the use of very small single-crystal specimens, between 10^{-7} and 10^{-8} g in weight, in conjunction with a high-intensity x-ray source. The special techniques which are required for the irradiation and subsequent manipulation of the specimens are described and the relative advantages of the micro-single crystal and conventional powder-diffraction methods examined. As examples of the use of the technique, some recent studies of structural damage in neutron-irradiated UC and UO_2 are briefly described. (auth)

33573 COMPARISON OF THE EFFECTS OF ELECTRON IRRADIATION ON THE OPTICAL ACTIVATION OF RACEMATES AND OF OPTICAL ANTIPODES. V. I. Gol'danskii and E. V. Egorov (Inst. of Chemical Physics, Academy of Sciences, Moscow). p.253-9 of "Radiation Damage in Solids. Vol. II." Vienna, International Atomic Energy Agency, 1962. (In Russian)

In view of reiterated reports in the literature stating that electrons emitted during beta-decay and even accelerated on a microtron have different effects on reflecting isomers, i.e., antipodes, detailed investigations were made to determine the effects of electron irradiation on the optical activation of solid racemates and the separate forms of optical isomers of 14 different organic compounds. The beta-active isotope Rh^{104}, a microtron and a cascade accelerating tube were used as electron sources. In all the cases investigated no optical activation was detected when the racemates were irradiated and there was no difference in the effects of the irradiation on the optical antipodes. It is proposed to carry out experiments in which pyro-crystals, i.e., optically active polarized targets, will be bombarded by polarized protons. (auth)

33574 MEASUREMENT OF THE INFLUENCE OF NEUTRON ENERGY ON THE EFFICIENCY OF PRIMARY COLLISIONS. P. Dulieu, J. C. Lanore, O. Rahmouni, and R. Schuttler (Centre d'Études Nucléaires, Paris). p.262-9 of "Radiation Damage in Solids. Vol. II." Vienna, International Atomic Energy Agency, 1962. (In French)

Results of a study concerning a semiconductor fast-neutron dosimeter are presented. The study was conducted to examine the possibility of correlating the energy response of the dosimeter to that of reactor materials. A discussion of results is included along with an estimate of measurement accuracy. (J.R.D.)

33575 A METHOD OF NUCLEAR SPOT-WELDING AND SOME OF ITS USES. V. I. Gol'danskii and V. V. Khrapov (Inst. of Chemical Physics, Academy of Sciences, Moscow). p.271-6 of "Radiation Damage in Solids. Vol. II." Vienna, International Atomic Energy Agency, 1962. (In Russian)

By utilizing the ability of B^{10} and Li^6 nuclei to produce a nuclear reaction under the action of thermal neutrons, the distinctive effect of spot-welding two materials was obtained. The results of experiments involving the radiation welding of a series of pairs of polymeric materials in the presence of compounds containing B and Li by irradiating the IRT-1000 reactor channel are described. The spot-welding of pairs like teflon-polystyrene, polyethylene-polystyrene and so on was attempted. A tighter linking of the rubber-caprone fabric pair was found. It is realized that the activation of many elements on being irradiated in a reactor may preclude wide-spread use; the method can be successfully used primarily with polymeric materials and those which do not contain activating elements such as Cl, S, P, most heavy metals. (auth)

PHYSICS

General and Miscellaneous

Refer also to abstracts 32908, 32909, and 33154.

33576 (AD-273228) INVESTIGATION OF THE MONOCAPILLARY THERMIONIC EMITTER AS A DUAL SOURCE OF IONS AND ELECTRONS. Quarterly Technical Progress Report No. 1. D. L. Dresser and W. Laurita (General Motors Corp. Allison Div., Indianapolis). Feb. 15, 1962. Contract AF33(616)-8299. 156p. (EDR-2617)

The capillary emitter is a new approach to thermionic energy conversion. In this concept, Cs flows through a refractory emitter structure so that the emitter becomes a dual source of ions and electrons. To determine the fundamental performance characteristics of the capillary emitter, a theoretical and experimental study was conducted on a monocapillary configuration. Theoretical work was directed toward the solution of the exact equation describing the flow of Cs through a capillary; several approaches to the solution of the integro-differential flow equation are discussed. Since none of these solutions were successful, a linear pressure drop model is used to predict capillary performance. The experimental device was a monocapillary emitter and collector structure to measure ion and electron emissions as a function of emitter temperature, Cs temperature, and spacing. The fabrication and assembly of the test devices are described in detail. (auth)

33577 (AE-79) DEPARTMENT OF REACTOR PHYSICS PROGRESS REPORT FOR PERIOD ENDING DECEMBER 1961. B. Tell, ed. (Aktiebolaget Atomenergi, Stockholm). Aug. 1962. 55p.

Research progress is reported on plasma physics, theoretical reactor physics, experimental reactor physics, numerical analysis, and general physics. (J.R.D.)

33578 (DASA-1264) FEASIBILITY OF SIMULATING THE MECHANICAL EFFECTS OF A NUCLEAR EXPLOSION USING NON-NUCLEAR EXPLOSIVES. Final Report. J. K. Crosby, J. O. Erkman, D. R. Curran, and J. B. Hull (Stanford Research Inst. Poulter Labs., Menlo Park, Calif.). Dec. 31, 1961. Contract DA-49-146-XZ-043. 140p. (AD-273158)

The feasibility of simulating ground motion produced by a nuclear detonation in or near the ground surface was established. In particular, the simulation of the physical input necessary to produce the ground motion in a restricted volume sufficiently great to encompass a buried structure was investigated. The volume in the ground affected by the detonation is divided into two regions, one affected primarily by direct coupling and the other affected indirectly, via the air shock. The simulation in each region was treated as a separate and independent problem. In both cases the effects to be duplicated are taken to be those calculated from direct coupling and air shock. (auth)

33579 (GA-2911) HIGH-TEMPERATURE, VAPOR-FILLED THERMIONIC CONVERTER. A. E. Campbell, F. D. Carpenter, J. B. Dunlay, and R. W. Pidd (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Feb. 15, 1962. Contract AF 33(616)-7422. 113p. (ASD-TR-61-513(Pt.II)).

Progress Development of a high temperature, vapor-filled thermionic converter for application with a nuclear reactor for space-vehicle electrical power generation is reported. Problems associated with the design and operation of a thermionic converter employing a UC-ZrC emitter, a cesium plasma for space charge neutralization, and a high-temperature collector are described. Emitter fabrication techniques are also described. A test cell employing a cylindrical UC-ZrC emitter, which was pressure bonded to a tantalum sleeve, and a low-temperature copper collector, was fabricated and operated for 400 hours to provide experimental data. The emitter was operated at temperatures of the order of 2000°C while the collector temperature was maintained at 200 to 300°C. A conceptual design for a thermionic power reactor incorporating the thermionic converter under development is also studied. It was concluded that a thermionic fuel element would be about 20 inches long and 0.68 inch in diameter and would incorporate 10 thermionic cells. The load voltage per fuel element would be about 14.5 volts and two elements would be connected in parallel (electrically) to provide an output of 29 volts. The over-all design would provide an electrical power level of approximately one megawatt. (auth)

33580 (HW-74190) PHYSICS RESEARCH QUARTERLY REPORT, APRIL–JUNE 1962. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 16, 1962. Contract AT(45-1)-1350. 38p.

Performance tests were carried out on a circuit designed to distinguish between recoil electrons and recoil protons, due to incident photons and neutrons, respectively, in a hydrogenous scintillator. The activities produced in lutetium foils by irradiation were found to be a function of thickness. Data are presented for correction of lutetium activity measurements from thick foils to that for thin foils. Subcritical experiments with 1.82 wt % Pu–Al rods in light water were conducted. A series of criticality experiments were begun with plutonium–nitrate solutions in a 14-in. diameter stainless steel sphere fully reflected with water. Monte Carlo calculations were made of the limiting critical concentration of Pu^{239} and U^{235} in aqueous solutions. (M.C.G.)

33581 (NASA-TN-D-1405) EXPERIMENTAL DETERMINATION OF SPECTRAL AND TOTAL TRANSMISSIVITIES OF CLOUDS OF SMALL PARTICLES. Chester D. Lanzo and Robert G. Ragsdale (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Sept. 1962. 41p.

Measured values of spectral and total transmissivities of clouds of small particles were obtained for carbon, tungsten, aluminum oxide, and hafnium carbide. The particles were dispersed in distilled water to decrease settling rates. Spectral values are presented for wave-lengths from 0.2 to 1.0 micron. Particle densities ranged from 10^{-6} to 10^{-4} grams per cubic centimeter of dispersion and particle diameters from 0.02 to 2.0 microns. Spectral measurements were made with a recording spectrophotometer. A xenon arc lamp and a radiation detector were used to obtain total transmissivities. The transmissivity measurements indicate that Beer's law is operative; that is, transmissivity varies exponentially with particle density. The transmissivity of carbon particles 0.08 to 1.4 microns in diameter was independent of wavelength for the range from 0.2 to 1.0 micron. A correlation of extinction coefficient per particle as a function of particle radius is presented. For constant particle weight per unit volume of dispersion, the transmissivity of carbon particles exhibited a minimum for a particle radius of 0.3 to 0.4 micron. In general, for a given weight of particles per unit volume and a given particle size, carbon particles

gave the least transmissivity, while aluminum oxide, hafnium carbide, and tungsten gave successively larger transmissivities. Light intensity measurements indicated that the attenuation of radiation by the carbon particles is the result of true absorption and not scattering. The measured transmissivity of 1.4-micron-diameter carbon particles indicated that a particle density on the order of 10^{-4} gram per cubic centimeter will absorb 98 percent of all radiation in the wavelength range from 0.2 to 1.0 micron in a path of 10 centimeters. (auth)

33582 (NRL-5828) RANGE-ENERGY RELATIONS FOR PROTONS AND ELECTRONS IN Al, Si, AND SiO_2. V. J. Linnenbom (Naval Research Lab., Washington, D. C.). July 13, 1962. 11p.

Range-energy relationships for protons penetrating Si and quartz are presented for the energy region 100 kev to 100 Mev. The range of protons in Si is obtained from range data in Al, corrected by the inverse mass stopping power ratio of the two elements. Low energy data (100 kev to 1 Mev) for Al are recalculated by graphic integration of the reciprocal mass stopping power curve. Ranges in Al for protons greater than 1 Mev in energy are taken from the literature. The data for SiO_2 are calculated from data on Si and gaseous O_2, based on Bragg's rule that the stopping power of a compound is equal to the sum of the contributions made by the individual atoms of the compound. To complete the picture, range-energy relationships for electrons are also presented. (auth)

33583 (PR-P-54) PHYSICS DIVISION PROGRESS REPORT, APRIL 1–JUNE 30, 1962. (Atomic Energy of Canada Ltd., Chalk River, Ont.). 78p. (AECL-1594)

Progress is reported on nuclear physics research, radioisotope standardization, computation, and developments in electronics. (M.C.G.)

33584 (TID-16718) THE TIME LAGS OF ELECTRICAL BREAKDOWN IN THE MAGNETIC FIELD. Technical Report No. 5. S. T. Nolan, H. W. Kendall, and J. W. Flowers (Florida. Univ., Gainesville). Aug. 20, 1962. Contract AT(40-1)-2783. 81p.

Using coaxial geometry and a pulsed transverse magnetic field, formative time lags were measured in air, argon, and helium at pressures varying from 0.2 mm Hg to atmospheric. The magnetic field intensities for the measurements varied from 0 to 90 kGauss with a pulse duration up to 140 microseconds. Static breakdown potentials as a function of a transverse magnetic field were measured by Wehrli who suggested that the effect of the magnetic field is the same as an increased gas pressure. Using this equivalent pressure concept, additional theoretical calculations were made concerning the effect on the Townsend coefficients. The time lag measurements show that the addition of a magnetic field has the effect of either increasing or decreasing the overvoltage depending upon the pressure range and the intensity of the magnetic field. The effective increase in overvoltage occurs only below and in the vicinity of the Paschen minimum using relatively small magnetic fields. Effective reduction of the overvoltage and prevention of the gaseous breakdown may be produced at any pressure by the application of a sufficiently large magnetic field. The equivalent pressure concept seems to be a good approximation to the phenomena observed. Measurements of decreased time lags at pressures greater than the Paschen minimum, abrupt cutoff magnetic intensities at low pressures, and exceeding large cutoff magnetic intensities at high pressures indicate that additional physical processes may be involved. Among these may be increased γ processes due to the decreasing grazing angle of ions on the cathode giving larger secondary yield of electrons, and the magnetic field curving elastically scattered energetic back to the cathode causing secondary emission. (auth)

33585 (AEC-tr-5356) APPLICATION OF DIMENSIONAL AND SIMILARITY METHODS TO THE THEORY OF CORONA DISCHARGE AT A CONSTANT VOLTAGE. N. N. Tikhodeev. Translated by Helen Basil (Argonne National Lab., Ill.) from Zhur. Tekh. Fiz., 25: 1257-64 (1955). 16p.

Models were developed for the study of electric current problems pertaining to the corona theory. Problems pertaining to electric currents in a gas and connected with the corona discharge at a constant voltage were examined from the point of view of the dimensional theory. A schematized presentation was developed for the discharge mechanism. A qualitative-theoretical analysis was made of corona theory electric current problems. (M.C.G.)

33586 THE BETHE-SALPETER EQUATION IN NONRELATIVISTIC QUANTUM MECHANICS. Silvan S. Schweber (Massachusetts Inst. of Tech., Cambridge). Ann. Phys. (N. Y.), 20: 61-77(Oct. 1962). (TID-15821)

It is shown that in nonrelativistic quantum mechanics, the Bethe-Salpeter equation reduces to the Schrödinger equation that determines the relative motion, by use of the translational invariance of the theory. (auth)

33587 GALILEI GROUP AND LIOUVILLE EQUATION. A. Loinger (Università, Pavia, Italy and Istituto Nazionale di Fisica Nucleare, Milan). Ann. Phys. (N. Y.), 20: 132-44(Oct. 1962).

Within the framework of the Hilbert space formulation of classical mechanics, the following results are proved: the values of the canonical Poisson brackets can be inferred from the postulate of the existence of an irreducible Abelian group of unitary ray rotations; and the only irreducible Hilbert representations of the proper Galilean group that are capable of a physical interpretation are those corresponding to the free-particle Liouville equation. (auth)

33588 QUANTUM THEORY OF TRANSPORT COEFFICIENTS. [PART] I. K. Baumann and J. Ranninger (Universität, Vienna). Ann. Phys. (N. Y.), 20: 157-70 (Oct. 1962).

The techniques of quantum field theory are applied to the electron-hole field interacting with the field of phonons in a crystal. The interaction is described by the Fröhlich Hamiltonian. In the evaluation of the electrical conductivity, an infinite number of Feynman diagrams has to be taken into account. The first three of these diagrams are worked out explicitly, and are found to be the beginning of a geometrical series, which yields functions for the conductivity. (auth)

33589 THRUST FROM PARTLY IONIZED MONATOMIC GASES. Herbert Beckmann and Alan J. Chapman (Rice Univ., Houston, Tex.). ARS (Am. Rocket Soc.) J., 32: 1369-73(Sept. 1962).

A monatomic, partly ionized gas with uniform stagnation properties is considered flowing in thermal equilibrium through a converging-diverging nozzle. The relationship is established between critical mass flow density and the following stagnation properties: pressure, enthalpy, and degree of ionization. Based on this relationship, thrust output at the throat as well as at large nozzle expansion ratios was analyzed for one-dimensional steady flow. For achieving the same nozzle efficiency, expansion ratios for the initially ionized gas have to be several orders of magnitude greater than in the case of conventional, unionized gases. The thrust output at the nozzle throat as compared to the maximum obtainable thrust, amounting

to 80% in the un-ionized case, may be as low as 50% for the fully ionized gas. (auth)

33590 THEORETICAL PERFORMANCE ANALYSIS OF A CONSTANT VELOCITY MHD GENERATOR FOR COMBUSTION PRODUCTS OF HYDROCARBON AND AIR. Sheldon Blecher (General Electric Co., Valley Forge, Penna.). ARS (Am. Rocket Soc.) J., 32: 1394-6(Sept. 1962).

Performance calculations of a magnetohydrodynamic generator are complicated somewhat because the gaseous electrical conductivity is a nonlinear function of pressure and temperature. This nonlinearity makes it impossible to integrate the equations analytically; if it is assumed that the conductivity is constant, this may lead to errors of a factor of 2 or more. When considering an oil combustion device as a thermal source for the working fluid, a path through an appropriate Mollier diagram must be determined. A method for representing a Mollier diagram analytically suitable for a computer was developed enabling all calculations to be performed on an LGP 30 digital computer. These calculations are performed along a constant velocity, d-c, MHD generator using stoichiometric products of hydrocarbon and air. The gas is assumed in thermal equilibrium and represented by a Boltzmann distribution so that the degree of ionization can be determined by means of the Saha equation. (auth)

33591 RADIATION FROM A GAS-FILLED VOLUME SOURCE PLACED BEHIND A FLAT SHIELD. E. E. Kovalev and D. P. Osanov. At. Energ. (USSR), 13: 68(July 1962). (In Russian)

The radiation from a cylindrical volume source, filled with a radioactive gas, was considered, choosing the energy of the γ radiation and the density of the uniformly distributed gas in such a manner as to result in a negligibly small self-absorption. Under these conditions, the attenuation factor K of the γ radiation level in the plane of the base of the source placed behind a shield is given by $K = [K'(p,k,\mu_2 d)]/[B(\mu_1 l)]$ where K′ refers to the attenuation factor without taking into account the single scattering in the shield and B is the buildup factor of the scattered radiation from a point source determined from the equivalent absorption length. The following approximation is proposed for the function: $K'(p,k,\mu_2 d) = Ae^{1.035\mu_2 d} + (1-A)e^{0.85\mu_2 d}$. In this case the coefficient A depends only on the parameters of the source, k (relative height of the cylinder) and on p (relative axial scattering). The precision of the computations carried out on the basis of this formula is about 10 to 15%. (TTT)

33592 THE BURSTING OF TUBES CONTAINING GAS DISCHARGES. R. A. Dugdale, R. C. McVickers, and S. D. Ford (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Brit. J. Appl. Phys., 13: 508-13(Oct. 1962). (AERF-R-4058)

During thermal shock in brittle materials by an intense gas discharge of 20 μsec duration, breakage of specimens and bursting of tubes sometimes occurs. Observations are made of the conditions under which these effects occur. Changes in strength and erosion of materials by the discharge are also studied. These observations suggest that breakage is not primarily a thermal shock effect but arises from an impulse generated within the tube. Experiments on the effect of tube material on specimen breakage, and comparison of the impulse produced in a silica tube to that in an alumina tube, suggest that, for glasses at least, the impulse is caused by a transient high pressure resulting from evaporation. A semi-quantitative discussion supports this conclusion. (auth)

33593 PROBE FOR MEASURING MAGNETIC FIELD WITH FOLDING COIL. M. Litomiský (Inst. of Nuclear Physics, Czechoslovak Academy of Sciences, Řež). Československ. časopis pro fysiku, 3A: 302-3(1962). (In Czech)

33594 THE INTERACTION PICTURE IN GRAVITATIONAL THEORY. John Carson Garrison (Purdue Univ., Lafayette, Ind.). Dissertation Abstr., 23: 656(Aug. 1962).

A quantized version of the Einstein theory of gravitation is considered in which the De Donder coordinate conditions, as formulated by Fock, are imposed as auxiliary conditions on the state vectors. These conditions are not generally covariant in form. The quantization is made possible, as in Fermi's form of quantum electrodynamics, by the addition of some terms to the original Lagrangian which are to vanish on account of the auxiliary condition. The conjecture of Fock that the De Donder-Fock coordinate conditions determine the coordinate system up to a Lorentz transformation is used to formulate the theory in a Lorentz-covariant way. For this purpose, a flat-space (Minkowski) metric $\gamma_{\mu\nu}$ is introduced in addition to the physical metric $g_{\mu\nu}$. The unitary transformation between the Heisenberg picture and the interaction picture is determined by the Tomonaga-Schwinger equation which is only defined for a certain class of spacelike surfaces. It is shown that the equation is integrable. The auxiliary condition in the interaction picture is found to have a form analogous to that of the corresponding condition in quantum electrodynamics. In the free-field approximation in which all gravitational self-interactions as well as interactions between the gravitational and other fields are ignored, it is shown that the auxiliary condition eliminates negative probabilities (which could occur because of the use of Gupta's indefinite metric) and ensures the positive-definiteness of the free-field energy.

33595 PART I. EXCITONS AND PLASMONS IN SUPERCONDUCTORS. PART II. LIFETIME EFFECTS IN CONDENSED FERMION SYSTEMS. Angelo Bardasis (Univ. of Illinois, Urbana). Dissertation Abstr., 23: 665-6(Aug. 1962).

I. The Anderson-Rickayzen equations of motion for a superconductor derived within the random-phase approximation (RPA) were used to investigate the collective excitations of superconductors. A spherical harmonic expansion was made of the two-body interaction potential $V(\vec{k},\vec{k}')$ and a spectrum of excitations whose energies lie within the energy gap 2Δ is obtained. The excitations may be characterized by the quantum numbers L and M involved in the potential expansion. Corrections to the Anderson-Rickayzen equations are discussed which lead to a new set of exciton states if the L-wave potential is repulsive. The excitons are interpreted as bound electron-hole pairs, as opposed to the particle-particle excitons present with an attractive L-wave potential. The electromagnetic absorption due to creation of particle-hole excitons was calculated. Therefore, within the limits of the bulk sample calculations, the creation of excitons cannot account for the precursor absorption observed in the far infrared frequency range experiments of others on thin films of lead and mercury. The experimental results are at least an order of magnitude greater than the theoretical ones. II. Within the two-component electron wave field formulation of Nambu, a general gap equation can be obtained which is valid for fermion systems interacting under arbitrary potentials. It was found that the damping of the normal state excitations have an effect of varying importance on the gap equation and the critical temperature, T_c. It is assumed that the normal state damping is of the form $i\alpha|p_0|^n \operatorname{sgn}(p_0)/p_0$, where α is a constant. The cases n = 0 and 1 are considered for a separable potential. For superconducting metals it was found that the inclusion of damping due to the Coulomb interaction cannot alter the gap results significantly. For

liquid He^3, the separable potential of cases n = 0 and 1 and an empirical damping factor obtained from thermal conductivity data led to a reduction of the critical temperature by a factor of three from the value obtained in the absence of damping.

33596 SUPERCONDUCTING PROPERTIES OF TIN, INDIUM, AND MERCURY BELOW 1° KELVIN. Douglas Kirby Finnemore (Univ. of Illinois, Urbana). Dissertation Abstr., 23: 666-7(Aug. 1962).

The critical field curves of superconducting tin, indium, and mercury were measured from T_c to 0.3°K. The measurements extend to sufficiently low temperatures to reach the region where the superconducting state entropy is negligible compared to the normal state entropy. From measurements in this low temperature range the normal electronic specific heat coefficient, γ, was determined. The superconducting entropy and specific heat derived from the data are presented. The data were compared with the theory of Bardeen, Cooper, and Schrieffer in two ways: values of the energy gap at T = 0, $2\Delta(0)$, derived from the measured values of H_0 and γ were compared with the theoretical value of 3.52 kT_c, and the temperature dependence of the measured critical field curves was compared with theoretical predictions. In addition, comparison was made between the measured critical field curves and curves obtained by scaling the BCS energy gap by a constant factor. Reasonable values of $2\Delta(0)$ were obtained, but the full range of superconducting state behavior does not completely agree with theoretical predictions. Near $T = T_c$ the energy gap derived from the critical field data rose more rapidly than would be predicted by scaling the BCS energy gap by the constant factor, $2\Delta(0)/3.52\ kT_c$. Results of the critical field measurements were compared with recent calorimetric data for tin and indium.

33597 THE THEORY OF PHASE TRANSITIONS IN SOLID HEAVY METHANE. William Charles Tait (Purdue Univ., Lafayette, Ind.). Dissertation Abstr., 23: 670(Aug. 1962).

A detailed treatment of the three solid phases in CD_4 is given to represent more accurately the fluctuating interaction of the molecules. The effect of the direct coupling between each pair of next-neighbor molecules is taken into account exactly. Their mutual interaction with the surrounding lattice is approximated by an average field. The requirement of self-consistency implies a set of integro-functional equations, which functions of molecular orientation must satisfy. The approach is supplemented by a more formal, but equivalent derivation. The free energy is simply related to a set of constants contained in the equations of the latter formulation. It is expected that only one solution, analogous to the disordered solution of ordered alloys, has physical significance at high temperature T. A method of successive approximation was used to find other solutions at low T. The high temperature phase was found to have a small but significant amount of local order. The orienting fields predicted for the intermediate and low temperature phases have the same general symmetry as those given by the internal field approximation. However, the degree of local order in the two phases was found to be roughly an order of magnitude greater than that predicted by the internal field approximation. The calculated value of the lower transition temperature, 25.2°K, was considerably higher than the observed value 22.2°K. The integrated heats of transition were also not in satisfactory agreement with observed values. (P.C.H.)

33598 THE GENERATION OF CONDENSATION NUCLEI BY IONISING RADIATION. W. J. Megaw and R. D. Wiffen (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Geofis. pura e appl., 50: 118-28(1961). (In English)

The production of condensation nuclei by the irradiation of filtered nuclei-free air by x rays, alpha particles, and beta particles is described. It is found that nuclei are created in large numbers by such irradiation and that there appears to be a threshold radiation dose at which the nucleus concentration is increased by a factor of more than a hundred. The effect of varying sulfur dioxide content of the irradiated air was investigated and for concentrations of between one and ten milligrams per cubic meter of air there is some proportionality between the sulfur dioxide content of the air and the nucleus concentration produced by a given radiation dose. It is shown, however, that sulfur dioxide cannot be exclusively responsible for the generation of condensation nuclei by irradiation of filtered air and other possible agents and mechanisms are suggested. (auth)

33599 IONIZATION EQUILIBRIUM IN AEROSOLS. V. P. V. Flanagan and T. C. O'Connor (University Coll., Galway, Ireland). Geofis. pura e appl., 50: 148-54(1961). (In English)

Theoretical and experimental investigations were made on the time taken to achieve equilibrium charge distribution on Aitken nuclei. Theory indicates that the fraction of nuclei uncharged approaches its equilibrium value exponentially, with an approximate half time value of 0.693 Z/4q and experiment gave good agreement with theory. The efficiency of a polonium-210 alpha ray source in producing ionization equilibrium in aerosols was examined and confirmed. The application of the methods described to the determination of the size of nuclei and to other observations in the free atmosphere are discussed. (auth)

33600 THE CONTENT OF SMALL AND LARGE RADIOACTIVE IONS IN THE AIR. J. Bricard (Faculté des Sciences, Paris), J. Pradel, and A. Renoux. Geofis. pura e appl., 50: 235-42(1961). (In French)

The proportion and free life time of RaA atoms arising from the radioactivity of atmospheric radon, and catched by dust particles, large ions, and condensation nuclei, is evaluated, with the assumption that these atoms are identical to the ordinary small ions. Experimental verification of the calculation are made by catching small and large ions with Zeleny tubes, the axial electrode being negatively charged. Other particles being catched with electrical precipitation and filter paper, activities of different samples are measured by α counting. 1.5×10^{-4} per cm^3 small ions RaA concentration was found. Knowing the air radon value concentration, and with the assumption of radioactive equilibrium only between radon and RaA in free air, it is possible to evaluate the concentration of RaA catched by other particles. (auth)

33601 THE ATTACHMENT OF NATURAL RADIOACTIVITY TO AEROSOLS. L. Lassen (Universität, Heidelberg). Geofis. pura e appl., 50: 281-5(1961). (In English)

The distribution of natural radioactivity on the different particle sizes in aerosols was studied both experimentally and theoretically. Experiments with artificial aerosols are in good agreement with theory in size range R = 0.04 to 5.0 μ. The results are applied to natural aerosols, including the influence of electrostatic forces (ionic diffusion) on the deposition process. (auth)

33602 FALLACIES IN DIRAC METHOD OF LINEARISING THE RELATIVISTIC HAMILTONIAN. K. C. Kar (Inst. of Theoretical Physics, Calcutta). Indian J. Theoret. Phys., 9: 7-11(Mar. 1961).

It is shown that Dirac's method of linearizing the relativistic Hamiltonian is open to many objections. In spite of these objections, correct results are obtained by convenient selection of matrices. (auth)

33603 THERMODYNAMICS OF SURFACE FILMS. E. N. Carabateas (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 33: 2698-2702(Sept. 1962).

A relation between the surface coverage and the surface potential of an adsorbed film is developed from a thermodynamic argument. It is found that proper variables for use in the theory of films are the temperature of the surface and the saturation temperature corresponding to the pressure of the vapor in equilibrium with the surface. The analysis is applied to experimental data for cesium on tungsten. An estimate of the range over which the surface forces extend is obtained by means of a simple microscopic model. (auth)

33604 INTERACTION OF PARALLEL DISLOCATIONS IN A HEXAGONAL CRYSTAL. Y. T. Chou (U. S. Steel Corp. Research Center, Monroeville, Penna.). J. Appl. Phys., 33: 2747-51(Sept. 1962).

Using the theory of anisotropic elasticity, the stress field of a single dislocation, the force between two parallel dislocations, and the stress field of various types of infinite dislocation walls and arrays are analyzed for a hexagonal crystal. The attraction sector of an edge dislocation with respect to another edge dislocation of the same sign is no longer the half-quadrant, as is found in the isotropic case. For graphite crystals the attraction sector is about 70° instead of 45°. The force between two parallel screw dislocations is not central. A tangential component exists that is zero along x and y axes. The tangential force retards the formation of screw dislocation arrays along any plane except those parallel or normal to the basal plane. Cross-slip may be aided or opposed by this force, depending on the direction of applied stress. The stress field of an infinite dislocation wall or array, either parallel or normal to the basal plane, has characteristics similar to those found in the isotropic treatment, although their magnitudes and geometries may differ considerably. Numerical data are tabulated for many common hexagonal crystals. (auth)

33605 A NEW SEMIEMPIRICAL EQUATION FOR GAS FLOW THROUGH CAPILLARIES. E. S. Creutz and L. R. Zumwalt (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Appl. Phys., 33: 2883-8(Sept. 1962).

An equation for gas flow through capillaries in low and intermediate pressure ranges is derived without attempting to distinguish between Poiseuille flow with slip and Knudsen flow. It is assumed simply that the total flow has two components, one characterized by an effective mean free path and the other by an effective viscosity, both of which depend on the ratio of the average pressure in the capillary to a characteristic pressure p_1 and, in addition, on the mean hydraulic radius of the capillary and properties of the gas. At low pressure, Knudsen flow is obtained, but in a form that separates out a term arising from a viscous effect related to the "free-molecule viscosity." At high pressure, Poiseuille flow with slip is obtained, but the slip term is cast in a form in terms of the characteristic pressure p_1. Also, the derived equation has a minimum in the relationship between the permeability and in the pressure, which is observed experimentally under some conditions. At this minimum, diffusion flow and viscous flow are equal in magnitude. At pressures below that corresponding to minimum flow, the phenomenon becomes more "diffusionlike" and at higher pressures more "viscouslike." Data on the flow rates of various gases through capillaries are well fitted by this equation at low pressure and in the "transition region" between Knudsen flow and Poiseuille flow. This fit is obtained by setting the adjustable constant α, which defines p_1, equal to unity. Elementary theory of the slip-flow correction also indicates that α should be about unity. Results obtained with this equation are compared with those obtained with Knudsen's four-constant formula. (auth)

33606 ISOTOPIC ABUNDANCE DETERMINATION OF COPPER BY SPUTTERING. F. A. White, J. C. Sheffield, and F. M. Rourke (General Electric Co., Schenectady, N. Y.). J. Appl. Phys., 33: 2915(Sept. 1962).

A spectrometer is described, in which an energy-resolved Cs ion beam sputters a Cu target at an incident energy of 0.3 to 3 kev. The sputtered Cu ions are then accelerated into a second part of the spectrometer, in which the Cu^{63} and Cu^{65} components are separated completely. The completeness of this separation indicates that the energy spread of the sputtered ions is less than 10 ev. The Cu^{63}/Cu^{65} isotopic ratio is found by this method to be 2.25 ± 0.02. (T.F.H.)

33607 SPUTTERING OF DIELECTRICS BY HIGH-FREQUENCY FIELDS. G. S. Anderson, Wm. N. Mayer, and G. K. Wehner (General Mills, Inc., Minneapolis). J. Appl. Phys., 33: 2991-2(Oct. 1962).

A method for sputtering insulators in the plasma of a low-pressure discharge is described. The method utilizes r-f fields, whereby the positive charge accumulation at the target surface, resulting from positive ion bombardment, is periodically neutralized during each cycle. The method has applications for cleaning, etching, and sputtering of insulators, as well as for removing deposits from observation windows. (auth)

33608 ENERGY GAPS OF THE III–V AND THE (RARE EARTH)-V SEMICONDUCTORS. N. Sclar (Nuclear Corp. of America, Denville, N. J.). J. Appl. Phys., 33: 2999-3002(Oct. 1962).

A simple empirical analysis allowing the prediction of the energy gaps of the III–V semiconductors and the rare-earth nitride, phosphide, and arsenide semiconductors is given. The analysis is based on a correlation of the semiconductor energy gaps with the ionic and covalent atomic radii of the constituent elements and is not sensitive to changes in crystal structure in going from one compound to the other. Agreement is obtained between the predicted and experimental values. (auth)

33609 SPACE-CHARGE NEUTRALIZATION AND NEGATIVE RESISTANCE IN THERMIONIC DIODES CONTAINING RADIOACTIVE KRYPTON. R. Forman and J. A. Ghormley (Union Carbide Corp., Parma, Ohio). J. Appl. Phys., 33: 3057-60(Oct. 1962).

Anode current-voltage characteristics of gas-filled thermionic diodes containing fission-product krypton were compared with characteristics of the same tubes containing natural krypton. Significant increases in current were observed in the diodes when radioactive krypton was substituted for natural krypton at pressures in the range of 20 to 340 mm Hg. In addition, diodes containing radioactive krypton displayed negative resistance. (auth)

33610 ANISOTROPY IN THE SUPERCONDUCTIVITY OF DEFORMED Re SINGLE CRYSTALS. J. J. Hauser (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 33: 3074-7(Oct. 1962).

Single crystals of rhenium with a resistivity ratio ($\rho_{300°K}/\rho_{4.2°K}$) of approximately 1500 were grown by the floating-zone technique. The crystals were then deformed by tension.

Samples were selected in which the deformation took place primarily on one slip system, i.e., on the $(10\bar{1}0)$ slip plane along the $(\bar{1}2\bar{1}0)$ slip direction. Measurements of the resistance were made to determine the variation of the critical current with applied magnetic field. The deformed samples revealed an anisotropy in the transition field (the transition field being the field at which the smallest measurable amount of normality was observed) that increased with decreasing current as the range where filamentary conduction was important was approached. The transition field was a minimum when the field was perpendicular to the active slip plane. The anisotropy at low current disappeared upon annealing the samples at 2700°C for 1.5 hr, and only the demagnetization effects remained. These results could be interpreted in terms of the anisotropic dislocation density introduced by this particular deformation. (auth)

33611 BREAKDOWN PHENOMENA IN THERMIONIC GAS-FILLED DIODES. J. Cleary (Newcastle University Coll., New South Wales, Australia). J. Appl. Phys., 33: 3143-4(Oct. 1962).

It is found that in a tungsten-filament diode filled with argon at about 50 mm Hg, the initial breakdown follows the relation $(V-V_0)(T-T_0) = C$ (V is the anode voltage, T is the cathode temperature in °K, and V_0, T_0, and C are constants), and that at higher voltages and currents a second "breakdown" occurs. This second transition is identified as the transition from glow to arc discharge. (T.F.H.)

33612 NEUTRON MAGNETIC FORM FACTORS AND X-RAY ATOMIC SCATTERING FACTORS FOR RARE-EARTH IONS. M. Blume (Atomic Energy Research Establishment, Harwell, Berks, Eng.), A. J. Freeman, and R. E. Watson. J. Chem. Phys., 37: 1245-53(Sept. 15, 1962).

The theory of neutron scattering by paramagnetic rare-earth ions was given by Trammell and more recently by Odiot and Saint-James. Unlike the case for the iron-series transition metals, for which the orbital angular momentum of the 3d electrons is almost completely quenched, the magnetic scattering of neutrons from the rare earths (except for gadolinium and europium) arises from both the spin and orbital contributions to the magnetization. Using recently determined Hartree-Fock wave functions for some of the trivalent rare-earth ions, the functions (j_n) and (g_n) (for n = 0, 2, 4, and 6) were determined which are necessary for the theoretical evaluation of the spin and orbital contributions, respectively, to the magnetic form factor. A comparison of these theoretical results with the experiments of Koehler and Wollan for Nd^{3+} and Er^{3+} and of Koehler, Wollan, and Wilkinson for Ho^{3+} is presented. Large differences are found between Trammell's theory and experiment and some possible reasons for this are discussed. X-ray atomic scattering factors for these ions are also given and found to agree very closely with the results of the Thomas-Fermi-Dirac statistical method. (auth)

33613 DETERMINATION OF GASEOUS-DIFFUSION COEFFICIENTS FROM VISCOSITY MEASUREMENTS. Stanley Weissman and E. A. Mason (Univ. of Maryland, College Park). J. Chem. Phys., 37: 1289-1300(Sept. 15, 1962).

Diffusion coefficients for pairs of simple gases were determined from the experimental viscosities of binary mixtures. The calculational procedure is essentially independent of any intermolecular-force model. The resulting diffusion coefficients are in good agreement with directly measured experimental diffusion coefficients, even in the temperature range where quantum effects are important. (auth)

33614 THEORY OF THE MAGNETIC SHOCK TUBE WITH VARYING DRIVING MAGNETIC FIELD. Michiru Yasuhara (Nagoya Univ., Japan). J. Phys. Soc. Japan, 17: 1488-96(Sept. 1962). (In English)

The inviscid flow of an ionized gas with infinite conductivity in a magnetic shock tube is treated, when the driving magnetic field is very strong, is time-varying, and is induced by the current discharge from capacitors. Two cases are treated: one-dimensional flow with a planar current sheet perpendicular to the flow; and cylindrically expanding flow with a cylindrical current sheet. The problem is analogous to the hypersonic flow past a slender body, and similarity solutions exist if the driving magnetic field varies proportionally to t^{k-1} (t is the time). Numerical results for several values of k are presented. For a general case, in which the magnetic field varies as an arbitrary function of time, an approximate method of calculation using the concept of local similarity is presented. (auth)

33615 STUDY OF PREFERRED ORIENTATION BY MEANS OF NEUTRON DIFFRACTION IN NUCLEAR MATERIALS. J. Laniesse, M. Englander, M. Lecomte, and P. Mériel (Centro Studi Nucleari, Saclay, France). Met. ital., 54: 283-4(July 1962). (In Italian)

Materials sufficiently drawn show preferred orientations which are revealed by x-ray inspection on a Debye-Scherrer plate on which, however, rings do not present a uniform blackening. This method becomes more difficult when the material is very absorbing. Neutrons, which generally are scarcely absorbed by the material, can take the place of x rays. The test device is a remake of that used for x rays, but the photograph plate is replaced by a meter, set according to Bragg's angle, beforewhich the Debye-Scherrer ring is compelled to pass by the turning of the sample on itself. A preliminary study of some uranium rough drawn bars in α phase, confirmed the preferred orientation of crystallites in directions parallel to the axis of drawing. Further research resulted in the anisotropy of graphite bars used in their reactors. As the bar is a parallelepiped referred to three axes xyz (z being the drawing axis), it is known that 001 planes of graphite grains tend mostly to take an orientation parallel to the axis of drawing. The anisotropy in xy plane, more difficult to be revealed, can be easily put in evidence and valued in figures owing to neutron diffraction. Cutting some samples from different points of the bar, it is possible to plot a distribution diagram of the normals to 001 planes in xy plane which shows that grains present a preferred orientation to the walls of the threading die. With slightly little different optics, neutron diffraction is also suitable for studying phase changes of high atomic weight metals. Another study concerns the kinetics of $U_\beta \rightarrow U_\alpha$ change of the uranium sample with 0.1% chromium content (in weight) at different temperatures. (auth)

33616 FUNDAMENTAL ADVANTAGES OF MHD POWER GENERATION. A. R. Kantrowtiz. Nippon Genshiryoku Gakkaishi, 4: 540-5(Aug. 1962). (In Japanese)

33617 MISSIONS FOR NUCLEAR INSTRUMENTS. Alastair G. W. Cameron (Goddard Space Flight Center, New York). Nucleonics, 20: No. 10, 50-4(Oct. 1962).

The various questions still unanswered in cosmic ray physics are discussed with reference to possible use of nuclear instruments on satellites and probes for the answers. Among the items discussed are galactic cosmic rays, solar cosmic rays, high- and low-energy gamma rays, trapped particles, interplanetary plasma, and abundance in space. (D.L.C.)

33618 HIGH-ENERGY GAMMA-RAY TELESCOPE. Nucleonics, 20: No. 10, 69(Oct. 1962).

A high-energy gamma telescope on Explorer XI detected 22 gamma rays with energies >50 Mev at a rate of 2.4 per hour. This rate is of the same magnitude as that expected from collisions of high-energy cosmic primaries with interstellar gas, indicating that the steady-state theory of the universe is wrong. The telescope comprises a sandwich crystal scintillator covered by a plastic anticoincidence scintillator, a photomultiplier, and a Cherenkov detector. (D.L.C.)

33619 EXTENDED FUNCTIONAL VARIATION. I. INVARIANCE TRANSFORMATIONS. D. G. B. Edelen (RAND Corp., Santa Monica, Calif.). Nuovo cimento (10), 25: 778-792(Aug. 16, 1962). (In English)

A general class of extended functional variations is considered, wherein the Lagrangian functions defining the action functionals are assumed to depend on the independent variables and on a collection of geometric objects. Necessary and sufficient conditions are obtained for the action functionals to remain invariant, under co-ordinate transformations and variations in the geometric objects, when these are restricted to a sufficiently small neighborhood of the identity element and the Lagrangian function is an assigned function of its arguments. Given a solution of the Euler-Lagrange equations, these conditions take the form of partial differential equations that the infinitesimal generators of the transformations and variations must satisfy. The results give a direct method for obtaining the collection of all generalized symmetries exhibited by the given solution of the Euler-Lagrange equations. It is shown that those transformations and variations referred to as invariance transformations characterize the properties of the given Lagrangian function, and result in invariance of the action functional in the strong sense (i.e., invariance of the action functional even if the Euler-Lagrange equations are not satisfied). (auth)

33620 EXTENDED FUNCTIONAL VARIATION. II. ON THE LAGRANGIAN CLASS ADMITTING A GIVEN INVARIANCE COLLECTION. D. G. B. Edelen (RAND Corp., Santa Monica, Calif.). Nuovo cimento (10), 25: 793-805(Aug. 16, 1962). (In English)

The following problem is investigated: determine the most general class of Lagrangian functions for which a given collection of co-ordinate transformations and variations of an arbitrary collection of geometric objects will leave the resulting action functional invariant in value. It is shown that in all cases, a system of either linear or quasi-linear first-order partial differential equations is obtained, whose solution manifold determines the required Lagrangian class. These results provide a direct means for determining the most general Lagrangian function that admits a given collection of generalized symmetries. If a set of transformations and variations T are invariance transformations for one Lagrangian function of the Lagrangian class L admitting T as an invariance collection, then T is shown to be a set of invariance transformations for every element of the Lagrangian class L. This result is nontrivial (since the equations that characterize an invariance transformation depend intrinsically on the Lagrangian function considered), and provides a basis for determining the most general Lagrangian function that results in strong invariance of the action functional (i.e., invariance of the action functional even if the Euler-Lagrange equations are not satisfied). (auth)

33621 STUDY OF NONINDEPENDENT RANDOM PULSE TRAINS, WITH APPLICATION TO THE BARKHAUSEN NOISE. P. Mazzetti (Istituto Elettrotecnico Nazionale Galileo Gerraris, Turin and CNR, Turin). Nuovo Cimento (10), 25: 1322-42(Sept. 16, 1962).

The correlation function and power spectrum are calculated for a train of pulses of exponential shape and random amplitude, distributed according to a law of probability experimentally found in research on the time interval distribution in the Barkhausen effect. All the features of the experimental power spectra of the Barkhausen noise can thus be completely explained. (auth)

33622 ON DETERMINING EXCITATION ENERGIES FROM THE POLES OF GREEN FUNCTIONS. D. Ter Haar and W. E. Parry (Clarendon Lab., Oxford). Phys. Letters, 1: 145-6(June 1, 1962).

The method of determining the low-lying excitation energies of a system by locating the poles of the Fourier transform of the single-particle Green's function for the system is shown to lead to incorrect results under certain circumstances. A system represented by a certain generalized Hamiltonian is shown as an example; the Green's function method for this system leads to several spurious energy levels. It is shown that the Green's function method is particularly inaccurate in perturbation theoretical approaches. (T.F.H.)

33623 EVIDENCE FROM MÖSSBAUER EXPERIMENTS FOR THE ASSOCIATION OF ALIOVALENT IONS AND VACANCIES IN POTASSIUM CHLORIDE. M. De Coster and S. Amelinckx (Studiecentrum voor Kernenergie, Mol, Belg.). Phys. Letters, 1: 245-6(July 1, 1962). (BLG-127)

The Mössbauer technique is used to study the association of aliovalent ions and vacancies in KCl. Monocrystals, doped with Co^{57}, quenched or slowly cooled, are analyzed. Direct evidence is found for the formation of impurity ion + vacancy complexes. (auth)

33624 DERIVATION OF THE LANDAU THEORY OF FERMI LIQUIDS. I. FORMAL PRELIMINARIES. P. Nozières (Ecole Normale Supérieure, Paris) and J. M. Luttinger. Phys. Rev., 127: 1423-31(Sept. 1, 1962).

The formal relationships necessary to derive the Landau theory of Fermi liquids are given. These include relationships between scattering functions for small energy and momentum transfers, vertex functions, and correlation functions. In addition certain identities (similar to identities encountered in quantum electrodynamics) are established, which enable the evaluation of these quantities. Finally, the form of all these relationships in the presence of a long-ranged Coulomb force is given. (auth)

33625 DERIVATION OF THE LANDAU THEORY OF FERMI LIQUIDS. II. EQUILIBRIUM PROPERTIES AND TRANSPORT EQUATION. J. M. Luttinger (Columbia Univ., New York) and P. Nozières. Phys. Rev., 127: 1431-40 (Sept. 1, 1962).

It is shown that a large class of the conclusions of the Landau theory of Fermi liquids may be established within the framework of many-body perturbation theory. Both equilibrium and transport phenomena are discussed. The theory is also carried out for long-ranged Coulomb forces. Finally, it is shown that a rather simple general expression for the quasi-particle distribution function of Landau may be given. (auth)

33626 SUPERFLUID HELIUM CRITICAL VELOCITIES IN A ROTATING ANNULUS. Philip J. Bendt (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 127: 1441-5(Sept. 1, 1962). (LADC-5275)

The critical velocity of rotation to bring superfluid helium at 1.3°K into motion is measured in an annulus 2.2 mm wide, 1.8 cm deep, and 8.83 cm mean diameter.

Superfluid currents are detected after the annulus is stopped, and after the normal fluid comes to rest, with a modified form of "Rayleigh disk." Well-defined critical velocities are found, and these vary from 0.81 cm/sec (1.75 rpm of the annulus) to 0.55 cm/sec (1.19 rpm) depending on the past history of the liquid. The higher critical velocity applies to liquid in which a superfluid current is not established previously. The "memory" of the liquid helium for previous superfluid currents lasts between 50 and 75 min. A discussion is given of the evidence that these currents constitute an irrotational velocity field ($v \propto 1/r$) in the annulus, free of vortex lines. (auth)

33627 SUPERCONDUCTING AND NORMAL SPECIFIC HEATS OF NIOBIUM. A. T. Hirshfeld, H. A. Leupold, and H. A. Boorse (Columbia Univ., New York). Phys. Rev., 127: 1501-7(Sept. 1, 1962).

Measurements reported are undertaken to determine the low-temperature heat capacity of niobium and to determine the effect of high-temperature annealing (2340°C) and degassing on a sample. The measurements cover the temperature interval 1.1 to 11.5°K and are significantly different from those obtained prior to the thermal treatment. The normal-phase heat capacity may be expressed by the usual relation, $C_n = \gamma T + \text{const } (T/\Theta_D)^3$, with $\gamma = (7.53 \pm 2\%)$ mJ/mole deg^2 and $\Theta_D = 238°K \pm 1.5\%$. The zero-field transition temperature, determined from the midpoint of the transition interval, is found to be 9.09°K. In the superconducting phase below 1.7°K, the total heat capacity C_s is found to be less than the lattice specific heat alone in the normal phase. This anomalous result is comparable to that found in indium. This anomaly complicates the determination of the superconducting electronic specific heat C_{es} but it may be evaluated to give $a\gamma T_c \exp(-bT_c/T)$, with a = 12.6 and b = 1.71. (auth)

33628 MAGNETIC HYPERFINE INTERACTION AND ELECTRONIC RELAXATION IN RARE-EARTH IONS IN EUROPIUM IRON GARNET. M. E. Caspari, S. Frankel, and G. T. Wood (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 127: 1519-29(Sept. 1, 1962).

The attenuation and rotation of the integral angular correlation for the 2^-(1409 kev)2^+(122 kev)0^+ γ-γ cascade in Sm^{152} following K capture in Eu^{152} and of the 1^-(1280 kev) 2^+(123 kev)0^+ γ-γ cascade in Gd^{154} are measured in polycrystalline samples of europium iron garnet from −25°C to temperatures above the Néel point, with and without a magnetizing field perpendicular to the counter plane. These data and differential angular correlation data are analyzed using a theory of time-dependent magnetic hyperfine interactions in magnetic materials. Explicit formulas for the dependence of the angular correlation on the electronic relaxation time, the average effective field acting at the nucleus in the direction of the magnetizing field (H^z_{int}), and the mean square fluctuating field (H^x_{int}), are given. The sign, magnitude, and temperature dependence of (H^z_{int}) in Sm^{152} are in agreement with the expectation value of H^z_{int} calculated from molecular field theory under the assumption that the electronic configuration following K capture in Eu^{152} is that of the Sm^{+3} ion. Crystalline field and quadrupole interaction effects are neglected. The contribution of the magnetic hyperfine interaction arising from the exchange between the 4f and inner core s electrons is small compared with that from the orbital and spin moments of the 4f shell. The value of the root-mean square hyperfine field is found to be 4.7×10^6 Oe and that of the average effective field to be 4×10^5 Oe at room temperature. The electronic relaxation time is 4×10^{-12} sec at room temperature and varies inversely with absolute temperature. The electronic state in Gd^{154} following beta decay in Eu^{154} is not determined. (H^z_{int}) is found to be 8×10^4 Oe at room temperature. (auth)

33629 MAGNITUDE OF EXCHANGE INTERACTIONS IN GADOLINIUM. D. A. Goodings (Univ. of Pittsburgh). Phys. Rev., 127: 1532-6(Sept. 1, 1962).

The effective nearest-neighbor exchange interaction J in gadolinium can be deduced from experiments in two ways. From a high-temperature expansion of the susceptibility and the measured value of the Curie temperature T_c, J is found to be 2.9°K, while from the low-temperature magnetization curve and simple spin-wave theory J is found to be 1.8°K. In order to clarify the reason for this discrepancy the low-temperature spin-wave problem is analyzed. Contributions to the magnetization from two different spin-wave modes are evaluated up to order $T^{\frac{5}{2}}$ and corrections arising from zone boundary effects are included. The analysis yields J = 2.1°K, and demonstrates that the magnetization follows a $T^{\frac{5}{2}}$ law very closely from low temperatures up to about 0.8 T_c because of a complicated cancellation of the higher-order effects. Finally, it is shown qualitatively that the remaining difference between the high- and low-temperature J values can probably be explained by the effect of interactions beyond nearest neighbors, and it is suggested that these interactions are on the average more antiferromagnetic than ferromagnetic. (auth)

33630 COLOR CENTERS IN ADDITIVELY COLORED CsBr. David W. Lynch (Ames Lab., Ames, Iowa). Phys. Rev., 127: 1537-42(Sept. 1, 1962). (IS-406)

Color centers are studied in CsBr single crystals additively colored with potassium or cesium. More than ten absorption bands are produced, most of which also exist in crystals colored by ionizing radiation. All bands produced by irradiation at or above liquid nitrogen temperature appear to arise from trapped electrons. The most prominent bands in the additively colored crystals are the F band at 642 mμ (liquid nitrogen temperature), and a band at 243 mμ, which appears to be caused by an impurity. Optically bleaching the F band at 200°K produces bands analogous to the M and R bands in other alkali halides, while bleaching at liquid nitrogen temperature yields a broad band identified as the F′ band. Evidence that the asymmetry of the F band arises from several excited states of the F center is presented. (auth)

33631 DIRECT OPTICAL DETECTION OF THE GROUND-STATE POPULATION CHANGES OF NEODYMIUM IN ETHYLSULFATE CRYSTALS. C. K. Asawa (Hughes Research Labs., Malibu, Calif.) and R. A. Satten. Phys. Rev., 127: 1542-8(Sept. 1, 1962).

A method is described for optically detecting population changes in paramagnetic salts, and is applied to the ground state of neodymium ethylsulfate and neodymium in lanthanum ethylsulfate. By observing the transmitted right or left circularly polarized light, the population of one of the ground Zeeman levels is selectively monitored. The ground-state population is changed by paramagnetic resonance and thermal relaxation processes. Knowing the ground state, the circular polarization of the light, and the selection rules, information about the excited states can be obtained. The spin-lattice relaxation time between Zeeman sublevels of the ground state is also obtained. After pulsing the microwave resonance transition, the decay of the transmitted light is observed; the decay curve is related to the spin-lattice relaxation curve. Relaxation-time measurements in the temperature range of 1.87 to 2.16°K are made in both the pure and dilute salt. The values range from 17 msec for the lower temperature to 11 msec for

the higher temperature. The slope of the relaxation time versus the temperature T indicates a temperature dependence for the relaxation time of $T^{-2.5}$ in this temperature range for 3% neodymium in lanthanum ethylsulfate and $T^{-1.7}$ for the neodymium ethylsulfate crystal. The crystal c axis is oriented parallel to the magnetic field of 4780 Oe; the microwave frequency is 23.6 kMc. (auth)

33632 EVIDENCE FOR HOPPING TRANSPORT IN BORON-DOPED DIAMOND. W. B. Wilson (General Electric Co., Detroit). Phys. Rev., 127: 1549-50(Sept. 1, 1962).

Electrical resistivity results were obtained from boron-doped natural and synthetic diamond from 88 to 293°K. Resistivities ranged from $\gg 10^{14}$ Ω-cm for undoped diamond to 10^{-2} Ω-cm for "heavily" doped diamond. Analysis of the activation energies, obtained from the temperature dependency of the resistivity, indicated anomalous behavior. The model proposed to explain the results was based on the impurity-level conduction scheme for compensated semiconductors. (auth)

33633 PRODUCTION OF CHARACTERISTIC X RAYS BY LOW-ENERGY PROTONS. R. C. Jopson, Hans Mark, and C. D. Swift (Univ. of California, Livermore). Phys. Rev., 127: 1612-18(Sept. 1, 1962). (UCRL-6724)

The cross sections for the production of characteristic x rays by targets bombarded with low-energy protons are measured for a number of elements. Scintillation counters capable of resolving x rays with energies as low as 2 kev are used as detectors. X rays from K, L, and M shells are observed and the behavior of the production cross section for these is measured as a function of incident proton energy. Proton beams with energies between 100 and 500 kev are used. The ionization cross sections for the shells are also computed using measured or extrapolated values of the appropriate fluorescence yields. The dependence of the K-shell ionization cross section on atomic number (Z) and on the energy of the bombarding protons is in accord with the theoretical predictions provided that the deflection of the bombarding particle by the Coulomb field of the nucleus is taken into account. The measured L-shell ionization cross sections are smaller than the values predicted by a Born approximation calculation in which Coulomb effects are neglected. Only a qualitative explanation of the behavior of M-shell ionization is presented. (auth)

33634 ACCURATE ANALYTICAL SELF-CONSISTENT FIELD FUNCTIONS FOR ATOMS. II. LOWEST CONFIGURATIONS OF THE NEUTRAL FIRST ROW ATOMS. E. Clementi (International Business Machines Corp., San Jose, Calif.), C. C. J. Roothaan and M. Yoshimine. Phys. Rev., 127: 1618-20(Sept. 1, 1962).

Self-consistent-field wave functions are obtained for the ground states of the first-row atoms and for the excited states belonging to the same configurations. The wave functions are the solution of the variational problem of finding the best orbitals for a given state, without any additional approximations except those inherent in the expansion method. (auth)

33635 ENERGY DISTRIBUTION OF ELECTRONS FROM IONIZING COLLISIONS OF ATOMS AND IONS. H. W. Berry (Syracuse Univ., N. Y.). Phys. Rev., 127: 1634-7(Sept. 1, 1962).

The energy distribution of electrons ejected in collisions of Ne ions with Ne and He atoms, He ions with Ne and Kr, and Xe ions and neutral atoms with Kr and Xe are measured, for ion energies from 0.3 to 3.0 kev. The spectra consist of a continuous distribution decreasing monotonically with electron energy, on which are superimposed electron groups of definite energy characteristic of the colliding particles. The nature and origin of these groups are discussed. (auth)

33636 ELECTRON IMPACT IONIZATION OF ATOMIC NITROGEN. A. C. H. Smith, E. Caplinger, R. H. Neynaber, Erhard W. Rothe, and S. M. Trujillo (General Dynamics/Astronautics, San Diego, Calif.). Phys. Rev., 127: 1647-9 (Sept. 1, 1962).

The total cross sections for the ionization of atomic nitrogen by electron impact are measured between 25 and 750 ev using a modulated molecular beam technique. The neutral beam source is a pulsed d-c discharge that dissociates about 20% of the molecules. The number of ions formed in a region defined by the intersection of an electron beam and the modulated molecular beam is compared with the number of ions formed when the neutral beams are partially dissociated. All ions are collected, including those energetic ones formed in the dissociative ionization of molecular nitrogen. The degree of dissociation is measured with a mass spectrometer. From the data, the ratios of the atomic to the molecular ionization cross section are obtained. The absolute atomic values are calculated by multiplying these ratios by the measured molecular ionization cross sections. (auth)

33637 STABILITY OF HARTREE-FOCK STATES. William H. Adams (Univ. of Uppsala). Phys. Rev., 127: 1650-8(Sept. 1, 1962).

The condition that must be satisfied by a Hartree-Fock wave function, if it is to give an absolute minimum of the energy, is derived by variation of the one-electron density matrix. If the energy is not an absolute minimum, the state is unstable. Introducing spin explicitly into the equations, it is found that there are two classes of variational functions that are particularly suitable in investigations of stability. One variation is related to the alternate orbital transformation, while the other is connected with Hund's rule and the conditions for ferromagnetism. The first of these variations is used in numerical examples. In the first example the stability of a restricted Hartree-Fock wave function for LiH relative to an unrestricted one is investigated. It is found that for the chosen basis set, the restricted Hartree-Fock wave function is stable at the equilibrium internuclear distance (3.0 a.u.), but that at 4.0 a.u. it becomes unstable. A second example investigates the relative stability of the restricted and unrestricted Hartree-Fock approximations for the electron gas. It is shown that at a sufficiently low density, the unrestricted Hartree-Fock method gives a lower energy. The resulting state has a nonzero spin density. The importance of the stability condition in atomic, molecular, and solid-state problems is emphasized. (auth)

33638 PERSISTENCY, PSEUDO-ENTROPY, AND THE THERMOKINETIC POTENTIAL. James C. M. Li (United States Steel Corp., Monroeville, Penna.). Phys. Rev., 127: 1784-6(Sept. 1, 1962).

The microscopic concepts of persistency, pseudo-entropy, and the rate of pseudo-entropy production, introduced from the viewpoint of path probability, and the macroscopic concept of thermo-kinetic potential, proposed from the viewpoint of Carathéodory's inaccessibility postulate or of the principle of macroscopic separability, are shown to agree with each other, within a constant numerical factor, near the steady state for two examples. (auth)

33639 GROUND STATE OF THE CHARGED BOSE GAS. M. Girardeau (Univ. of Chicago). Phys. Rev., 127: 1809-18(Sept. 1, 1962).

The ground-state energy of the charged Bose gas is calculated by a pair-correlation variational method. The

method is exact in the high-density limit ($r_s \ll 1$) and provides a variational extrapolation to intermediate densities. The leading terms of the high-density expansion, obtained by iteration of the variational integral equation, are $u_0 = -0.804r_s^{-\frac{1}{2}} - (1/8)\ln r_s + O(1)$, where u_0 is the ground-state energy per particle in Rydbergs and r_s is the ratio of the mean interparticle spacing to the Bohr radius. The logarithmic term is related to screening of the long-range correlations at a distance $r_0 \sim r_s^{-\frac{1}{2}}\rho^{-\frac{1}{2}}$, in analogy with the logarithmic term in the correlation energy of the electron gas. Results of numerical solutions for the intermediate-density region are presented, ranging up to $r_s = 10$. On the basis of a comparison with the energy calculated from the low-density expansion, it is estimated that the transition into Wigner's electron crystal (here a boson crystal) should occur at $r_s \sim 5$. (auth)

33640 SCATTERING OF ELECTROMAGNETIC PLANE WAVES FROM INHOMOGENEOUS SPHERICALLY SYMMETRIC OBJECTS. Philip J. Wyatt (Plasmadyne Corp., Santa Ana, Calif.). Phys. Rev., 127: 1837-43(Sept. 1, 1962).

The scattering of light from spherically symmetric inhomogeneous absorbing particles cannot in general be predicted directly from solutions of the conventional wave equation. An exact theory is derived from Maxwell's equations, and the resultant scattering coefficients are found to depend upon the solutions of two differential equations, one of which is of the Schrödinger form. Specific calculations based on form factors illustrate the dependence of the polarization and scattered intensities on surface diffuseness. (auth)

33641 NEW APPROACH TO FORCE-FREE MAGNETIC FIELDS. G. L. Hand and M. A. Levine (Air Force Cambridge Research Labs., Bedford, Mass.). Phys. Rev., 127: 1856-7(Sept. 15, 1962).

A practical force-free magnetic field must consist of two regions — one conducting and one nonconducting. The boundary between these two regions must have a magnetic field whose intensity is inversely proportional to radius in a cylindrical coordinate system. A unique solution to this problem for an azimuthal symmetric case is found. This solution satisfies the field equations, on the boundary, of curl $H = 0$ and $H \sim 1/r$. (auth)

33642 ELECTRON WAVE FUNCTIONS IN METALLIC LITHIUM. Joseph Callaway (Univ. of California, Riverside) and Walter Kohn. Phys. Rev., 1913(Sept. 15, 1962).

Wave functions to order k^2 are presented for electrons in metallic lithium. The calculation is an application of the cellular method. An empirical potential is employed. (auth)

33643 PROJECTED WAVE-FIELD APPROACH TO THE MANY-ELECTRON PROBLEM IN SOLIDS. Franco Bassani (Argonne National Lab., Ill.), John Robinson, Bernard Goodman, and J. R. Schrieffer. Phys. Rev., 127: 1969-79(Sept. 15, 1962). (TID-15897)

The orthogonalized plane wave (O.P.W.) method for treating electrons in solids is generalized to the many-body problem. The core electrons are assumed to be dynamically independent of the valence electrons. Using a field-theoretical approach, a model wave field is introduced whose valence projection is the valence wave field of the physical system. When an appropriate choice is made for the model Hamiltonian, the rapid convergence of the O.P.W. method is incorporated in the many-body perturbation expansion. An attractive feature of the scheme is that the perturbation expansion can be carried out using zero-order Green's functions appropriate to free electrons. The single-particle self-energy to low order is the sum of the one-body O.P.W. contribution and a screened exchange energy similar to that obtained in the case of the uniform electron gas. The theory is expected to be useful for metals and valence crystals for which the single-particle O.P.W. method is appropriate. (auth)

33644 PRECISE CRITICAL-FIELD MEASUREMENTS OF SUPERCONDUCTING Sn FILMS IN THE LONDON LIMIT. D. H. Douglass, Jr. (Massachusetts Inst. of Tech., Cambridge) and R. H. Blumberg. Phys. Rev., 127: 2038-43(Sept. 15, 1962).

Precise measurements of the critical field of superconducting tin films are made as a function of temperature and thickness. Particular attention is paid to measurements near the transition temperature where the London limit holds. It is found that near the transition temperature the critical field can be expressed in the form $H_c = (\Delta t)^{\frac{1}{2}}\gamma(1 + \epsilon\Delta t)$, where γ and ϵ are independent of temperature and $\Delta t = 1 - T/T_c$. In terms of the Ginzburg-Landau theory modified to include the lower temperatures, the constant γ determines the penetration depth and the constant ϵ is different for different modifications of the field-independent free energy. Penetration depths determined in this way are found to be a function of thickness. Assuming that the coherence length ξ in the film is determined by the thickness and using an expression for the thickness dependence of the penetration depth, a bulk coherence length ξ_0 of approximately 2100 Å can be obtained. This way of determining ξ_0 is quite different from the high-frequency method, and is proposed as an independent and alternative method. Two particular modifications of the Ginzburg-Landau theory are considered. They predict values of ϵ of 0.31 and −0.19 respectively. Experimentally, ϵ is determined to have an average value of 0.14 ± 0.10. (auth)

33645 ELECTRICAL AND MAGNETIC PROPERTIES OF HOLMIUM SINGLE CRYSTALS. D. L. Strandburg, S. Legvold, and F. H. Spedding (Ames Lab., Ames, Iowa). Phys. Rev., 127: 2046-51(Sept. 15, 1962). (IS-446)

Magnetic moment measurements are made on holmium single crystals (hcp) from 1.3 to 300°K in magnetic fields from 250 to 18,000 Oe, with the field applied along the c axis, the a axis, and a $(10\bar{1}0)$ direction. The $(10\bar{1}0)$ direction is the direction of easy magnetization with an extrapolated effective moment per atom at saturation of 10.34 Bohr magnetons. Basal plane measurements show antiferromagnetism below the Néel temperature of 132°K with basal plane anisotropy occurring below 80°K. Below the Néel point, an anomalous type of transition to ferromagnetic behavior upon application of sufficient field is observed. Magnetization curves for the c axis are linear down to 60°K, while measurements below 20°K show an initial magnetization of approximately 1.7 Bohr magnetons followed by nearly linear magnetization curves. Electrical resistivity measurements are made from 4.2 to 300°K. For the a axis, the resistivity changes slope slightly at 20°K. A larger change in slope occurs at the Néel temperature of 132°K. For the c axis, the resistivity changes slope slightly at 20°K, reaches a peak at 120°K, goes through a minimum at 132°K, and remains constant until approximately 150°K, after which it increases linearly with increasing temperature. (auth)

33646 NEUTRON DIFFRACTION DETERMINATION OF ANTIFERROMAGNETISM IN FACE-CENTERED CUBIC (γ) IRON. S. C. Abrahams (Bell Telephone Labs., Murray Hill, N. J.), L. Guttman, and J. S. Kasper. Phys. Rev., 127: 2052-5(Sept. 15, 1962).

Microcrystalline particles of γ iron of nearly identical orientation in a single-crystal copper matrix give a neu-

tron diffraction pattern, in the liquid helium temperature range, consistent with the development of antiferromagnetism. The spin structure resembles that of γ manganese, but with the spin vectors inclined at about 19° from the normal to the ferromagnetic sheets. The spin directions in alternative sheets are antiparallel. The moment per iron atom is about 0.7 Bohr magnetons and the Néel temperature, estimated from the Brillouin function temperature dependence of the magnetic intensities, is about 8°K. (auth)

33647 NEUTRON DIFFRACTION STUDIES ON EuO. N. G. Nereson, C. E. Olsen, and G. P. Arnold (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 127: 2101-4 (Sept. 15, 1962). (LADC-5250)

Neutron diffraction studies on EuO at various temperatures are made at a neutron wavelength of 1.391 Å. The experimental data confirm the existence of ferromagnetism in this compound at temperatures below the Curie point (77 ± 1°K). The intensities of the magnetic reflections vary with temperature according to the square of a Brillouin function having a spin of $^7/_2$. The magnetic scattering data also provide information on the magnetic amplitude form factor for Eu^{2+} over the region from $(\sin\theta)/\lambda = 0.17$ to 0.32, and indicate that the form factor decreases to half-value at $(\sin\theta)/\lambda = 0.29$. The nuclear scattering data of EuO show that the absolute value of the neutron coherent scattering length for Eu is $|f_{Eu}| = (0.63 \pm 0.03) \times 10^{-12}$ cm; the experimental value for the Eu nonresonant coherent scattering length is $f_0(Eu) = (0.88 \pm 0.04) \times 10^{-12}$ cm. (auth)

33648 DISPERSION RELATIONS FOR ELECTRON SCATTERING FROM ATOMIC HELIUM. Edward Gerjuoy (RCA Defense Electronic Products, Princeton, N. J.) and Nicholas A. Krall. Phys. Rev., 127: 2105-13(Sept. 15, 1962).

Dispersion relations are deduced appropriate to the scattering of electrons by helium atoms in either the ground state or the first excited metastable state. The analysis points out that in the case of scattering from excited He the dispersion relation generally involves an integral over unphysical energies, as well as residue contributions from bound states of He^- embedded in the continuum. The symmetries of those He^- bound states making nonvanishing residual contributions, and the form of the optical theorem when the exclusion principle is taken into account, are also discussed. (auth)

33649 SPHERICAL LATTICE GAS. H. A. Gersch (Georgia Inst. of Tech., Atlanta) and T. H. Berlin. Phys. Rev., 127: 2276-83(Sept. 15, 1962).

Some features of the canonical partition function for the spherical model of a lattice gas are given. The equation of state is obtained for all densities and temperatures, and predicts that the pressure remains constant in the transition region. The particle correlations and fluctuations are calculated, and their behavior in this region is shown to be consistent with a phase transition. A physical interpretation of the normal modes of the spherical model indicates that the model contains the general aspects of clustering of particles. The origin of an anomalous behavior of the model, consisting of the pressure becoming negative for all temperatures at sufficiently large specific volumes, is described and a method for eliminating it is introduced. (auth)

33650 NEUTRON DIFFRACTION INVESTIGATION OF ANTIFERROMAGNETIC K_2NiF_4. E. Legrand and R. Plumier (Centre d'Etude de l'Energie Nucléaire, Mol, Belg.). Phys. Status Solidi, 2: 317-20(1962). (BLG-81). (In English)

A neutron diffraction study of powdered K_2NiF_4 was made at 21, 77, and 298°K. In this tetragonal layer-type structure, the magnetic moments within each sheet are couples antiferromagnetically; they are found to be parallel to the C-axis. (auth)

33651 LATTICE PARAMETER EFFECT ON THE ISOMERIC SHIFT. H. Pollak (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Phys. Status Solidi, 2: 417-20 (1962). (BLG-115). (In English)

By assuming that the number of conduction electrons is not perturbed by a slight hydrostatic pressure, the nuclear energy shift of the 14.4 kev gamma ray of Fe^{57} resulting from compression in an iron crystal was computed. The atomic wave functions are those of the free atom but they are no longer allowed to extend to infinity: they are limited to the Wigner-Seitz polyhedron. For a pressure of 3000 kg/cm², the calculated shift is 0.83×10^{-10} ev as compared to the experimental value of 1.12×10^{-10} ev obtained by Pound. (auth)

33652 Fe^{3+} ION LIFETIME IN CoO DEDUCED FROM THE AUGER AND MÖSSBAUER EFFECTS. H. Pollak (Studiecentrum voor Kernenergie, Mol, Belg.). Phys. Status Solidi, 2: 720-4(1962). (BLG-111). (In English)

A theoretical study is made of the Auger cascades which follow the capture of electrons by Co^{57} nuclei, taking into account the Coster-Kronig transition. The mean lifetime of trivalent Fe^{57} ions located at Co sites in CoO is calculated using the experimental ratio of the concentrations of bivalent and trivalent Fe^{57} ions. (auth)

33653 THE THERMIONIC ENERGY CONVERTER—A PROMISING HEAT ENGINE. B. S. Leo (Douglas Aircraft, Santa Monica, Calif.). Power Eng., 65: 49-51(May 1961).

The principles of thermionic converters are reviewed in some detail, and the energy levels of the free electrons are discussed. Equations are given for calculating the efficiency. Thermionic converters which have been tested are described and their characteristics given. (D.L.C.)

33654 INVESTIGATION ON THE GAS IONIZING RADIATION OF A DISCHARGE. [PART] II. A. Przybylski (Universität, Hamburg). Z. Physik, 168: 504-15(1962). (In German)

This paper gives a report on measurements of the coefficient of absorption and intensities of gas-ionizing radiation emitted by a gas discharge. Earlier measurements in oxygen with a discharge in a cylindrical electric field yielded components of radiation with values of $\mu \approx 550$, 250, and μ 38 cm^{-1} at 760 mm Hg. By new measurements using a spark discharge an additional component with a value of $\mu = 2.5$ was found, which already had been measured by other authors. Measurements with mixtures of oxygen and nitrogen are compared with results of measurements in air. From this it may be deduced that the gas-ionizing radiation effective in air is essentially emitted by nitrogen and ionizes oxygen, the coefficient of absorption being about $\mu \approx 5$ cm^{-1}. The number of ionizing quanta emitted per ionizing collision of electrons in the discharge tube is about 10^{-3} for oxygen, nitrogen, and air. In oxygen this figure proves to be essentially independent of E/p. In air, however, this figure is reduced with increasing values of E/p. The absorption of the ionizing radiation in air is increased by the addition of methane (μ = 960 cm^{-1} for 760 mm Hg of methane). In carbon dioxide several components of ionizing radiation are found, with coefficients of absorption in the range $200 < \mu < 800$. (auth)

33655 LUMINESCENCE OF ZnS PHOSPHORS DURING BRIEF EXCITATION. Hugo Ball (Technische Hochschule, Munich). Z. Physik, 168: 516-29(1962). (In German)

The theory of Riehl and Schön for the luminescence of

ZnS phosphors leads to a bimolecular mechanism. Thus in a starting range still far from saturation, the luminescence would increase in the second power with the stimulation intensity. The starting intensity of several phosphors was measured at stimulation time between 10^{-5} to 1 sec. The theory of Riehl and Schön was confirmed. Measuring results proving a higher increase than the second power could equally be explained by this theory. (auth)

33656 THE LUMINESCENCE OF STRONTIUM OXIDE–CERIUM OXIDE SYSTEMS. H. Witzmann and G. Herzog (Universität Greifswald, Ger.). Z. Physik. Chem. (Leipzig), 219: 369-86(1962). (In German)

The intensity of cerium-activated SrO phosphors was determined as a function of the activator concentration, the glow duration, and the glow temperature. The fluorescence of the systems exists at concentrations from 10^{-4} to 4 g Ce/per g of SrO. The optimum intensity was at 2.5×10^{-2} g. A displacement of the emission maximum at 460 mμ, independent of Ce concentration, was not observed. The absorption spectrum indicates that light absorption follows the Ce concentration. The glow atmosphere is without effect on the valency of the activator. The quantum yield of the system was determined as Q = 0.2 with respect to magnesium tungstate. (J.S.R.)

33657 INVESTIGATIONS OF MAGNETIC AND ELECTRIC FIELDS IN GASEOUS MEDIA WITH THE AID OF ELECTRON BEAMS. A. M. Trokhan. Zh. Prikl. Mekhan. i Tekhn. Fiz., No. 4, 90-4(July–Aug. 1962). (In Russian)

Magnetic and electric fields were investigated using beams of fast monoenergetic electrons. The trajectories of the electrons were observed by the fluorescence caused by the electrons as they passed through the gaseous medium. The trajectories were then photographed. It was concluded that while magnetic and electric fields can be investigated by the above-described method it is absolutely necessary to use electron beams of sufficient intensities. It was also concluded that foil windows cannot be used for the entrance of these electron beams from vacuum into the gas because of the boundary current density. Such foil windows also destroy the monoenergetics of the initial beam. It is therefore necessary to utilize gasodynamical windows. The work was carried out using a differential gasodynamical window designed by S. T. Sinitsin. (TTT)

33658 LIQUID METAL FARADAY-TYPE MHD GENERATORS. W. D. Jackson (Massachusetts Inst. of Tech., Cambridge, Mass.). Preprint Paper No. CP-62-1401. Prepublication Copy. 15p. $1.00.

The use of a liquid metal as the working fluid in MHD generators is considered and possible energy conversion applications for this type of generator are briefly reviewed. A simple model of the Faraday-type generator is developed and used to obtain relations giving generator terminal voltage, pressure drop, and efficiency. The generator performance is shown to depend on a magnetic Reynolds number based on the length of the generator duct and also on the ratio of machine internal resistance to electrical load resistance. The existence of an effect analogous to armature reaction in conventional machines is deduced and the use of compensating conductors to overcome it is discussed. The problems of generator design are considered and examples are used to illustrate the effect of losses in a practical generator. It is concluded that compensation is necessary in all but the smallest machine sizes. (auth)

Astrophysics and Cosmology

33659 (NASA-TN-D-1474) ENVIRONMENTAL PROBLEMS OF SPACE FLIGHT STRUCTURES. I. IONIZING RADIATION IN SPACE AND ITS INFLUENCE ON SPACECRAFT DESIGN. Louis F. Vosteen (National Aeronautics and Space Administration. Langley Research Center, Langley Station, Hampton, Va.). July 19, 1962. 34p.

The present state of knowledge of the natural radiation environment of space is discussed and the manner in which the environment may interact with space vehicles is examined. The radiation damage to various materials and spacecraft components is indicated and the selection of materials best suited for use as radiation shields is discussed. The necessity for providing protection against biologically damaging radiation is shown to be of prime concern for manned vehicles. (auth)

33660 AMBIENT XENON: A KEY TO THE HISTORY OF METEORITES. Robert A. Fish (Lick Observatory, Mt. Hamilton, Calif.) and Gordon G. Goles. Nature, 196: 27-31(Oct. 6, 1962).

Xenon exhibits a special anomaly in many meteorites in which Xe^{129} is greatly enhanced with respect to terrestrial Xe. Smaller general anomalies also affect the remainder of the Xe isotopes. It is postulated that the xenon special anomalies are a result of the meteorite parent bodies having formed quickly enough after the last synthesis of I^{129} to permit an excess of the radiogenic daughter Xe^{129} to accumulate in the iodine-bearing minerals. Since it is not certain which processes contributed to the nucleosynthesis of iodine, relative rather than absolute decay intervals can be derived. It is suggested that radiogenic Xe^{129}, from I^{129}, and Xe^{131} to Xe^{136}, from fission of heavy elements, was produced in those regions of the parent body that were at relatively high temperatures and mixed freely with the ambient xenon, so that the isotopic abundance in ambient xenon of Xe^{129} and Xe^{131} to Xe^{136} increased with time. Applications of xenon chronometry in studies on the interiors of meteorite parent bodies are discussed. Data on the xenon content of the Sardis iron troilite and of Abee are compared. An ideal model is presented and theoretical measurements of xenon isotopic abundance are compared with measurements on Abee. Equations are presented for the correlation of Xe^{129}/Xe^{132} and Xe^{128}/Xe^{132}, in which consideration is given to the effects of temperature on the release of xenon from iodine-bearing minerals. It is suggested that the method may be applied in studies on environmental parameters of meteorites of different types and should give new insight into the significance of the high- and low-iron groups of chrondrites, the gallium-germanium group of meteorites, and the clusters of cosmic ray ages. (C.H.)

33661 TWO METEORITES OF UNUSUALLY SHORT COSMIC-RAY EXPOSURE AGE. Edward Anders (Univ. of Chicago). Science, 138: 431-3(Oct. 19, 1962).

The chondrites Cold Bokkeveld and Farmington seem to have reached the earth less than 200,000 years after they left their parent body. Either these meteorites came from the moon, or, more probably, the collision life times of interplanetary objects are occasionally much shorter than has been assumed heretofore. (auth)

Cosmic Radiation

33662 A STUDY OF UNDERGROUND COSMIC-RAY MUON INTENSITIES AT VERY LARGE ZENITH ANGLES. Orville Lee Smith (Univ. of Missouri, Columbia). Dissertation Abstr., 23: 664(Aug. 1962).

Underground cosmic-ray muon intensities were investigated at zenith angles from 71 to 89° for oblique depths from 82 meters of water equivalent to 362 meters of water equivalent of rock. The investigation was made near sea-

level with a hodoscope-telescope, and the absolute intensities were measured in an underground limestone quarry behind a smooth vertical bluff. From the data, the sea-level energy spectra were inferred for energies between 15 and 90 Bev. The slopes of the energy spectra at fixed zenith angle were found to increase with energy, reflecting the increasing atmospheric absorption loss of parent pions as their mean lifetimes increased with energy. In addition the slopes were found to decrease with increasing zenith angle at fixed energy, reflecting the decreasing loss of pions at high altitudes by absorption as the average density of air per unit of path length decreased. The zenithal dependence of the sea-level muon intensity was also inferred at fixed energies from 20 to 90 Bev for angles between 70 and 90°. The experimental results are shown to be in good agreement with theoretical predictions of others at angles near 70°. Discrepancies observed at higher angles are explained in terms of the flat-atmosphere approximation used in the theory. The results suggest a pi-meson absorption mean-free-path between 60 and 120 g/cm^2, with no evidence for a value above 120 g/cm^2. The exponent of the differential pi-meson production spectrum was determined to be 2.66 ± 0.06, and it is shown to be independent of zenith angle and energy in the intervals investigated.

33663 POLARIZATION OF COSMIC MUONS OF VARIOUS ENERGIES. B. A. Dolgoshein, B. I. Luchkov, and V. I. Ushakov. Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 711-12 (June 1962). (In Russian)

The polarization of muons, in the energy region 0.2 to 1.55 Bev, was measured by studying the asymmetry arising from the decay of these muons into electrons. The muons were stopped in a copper target surrounded by several layers of Geiger counters operating in the high-voltage region. The decay curve yielded a lifetime for the muon of 2.19 ± 0.04 microsec. In all, approximately 4×10^4 muon decays into electrons were registered. The measurements were carried out at the following energies: 0.2, 0.3, 0.55, 1.05, 1.4, and 1.55 Bev. The polarization was found to increase from 0.24 ± 0.04 at 0.2 Bev to 0.40 ± 0.05 at 1.55 Bev. The theoretical values of the polarization at these two energies are 0.23 and 0.34, respectively. (TTT)

33664 POLARIZATION OF COSMIC μ-MESONS. A. I. Alikhanian, T. L. Astiani, V. M. Krishian, E. M. Matevosian, and R. O. Sharakhatunian. Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 713-15(June 1962). (In Russian)

The polarization was measured for muons with a momentum of 2.1 Bev/c by stopping the muons in a copper target surrounded by four layers of Geiger counters. The stopping of a muon in the copper registered a coincidence in layers I and III and an anticoincidence in layer IV. The resolution of the detection system was 5×10^{-7} sec. The copper target was wrapped in a solenoid which could be operated at a magnetic field of 80 Gauss. The value of R_0/R_{80} was found to be 1.20 ± 0.03, where R is the ratio of the number of positrons emitted up to the number emitted down; R_0 and R_{80} refer to the ratios with the magnetic field being off and on, respectively. From this value of R_0/R_{80} the muon polarization was determined to be 0.29 ± 0.03. (TTT)

33665 COMPOSITION OF THE FLUX OF NUCLEAR-ACTIVE PARTICLES IN COSMIC RADIATION IN THE MOMENTUM REGION ABOVE 1.8 Bev/c, AT AN ALTITUDE OF 3250 m ABOVE SEA LEVEL. [PART] I. A. V. Khrimyan, V. V. Avakyan, N. A. Nalbandyan, K. Sh. Egiyan, and M. P. Pleshko (Physical Inst., Academy of Sciences, Armenian SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 722-7(June 1962). (In Russian)

An investigation was made to determine the number of π-mesons in the flux of nuclear-active cosmic rays, with momenta above 1.8 Bev/c. The apparatus consists of a 6850 mass spectrometer, arrays of proportional and scintillation counters, and copper and lead absorbers. It affords a measurement of the momentum of a particle, the ionization produced by it, as well as other characteristics determined from the interaction in the copper and lead filters located underneath the mass spectrometer. By suitable counter gating the apparatus discriminates against energetic electrons, μ-mesons, and particles created within the experimental equipment itself. Since the pion inelastic cross sections are independent of momentum above 2 Bev/c, the number of pions in the flux of nuclear active particles can be determined from the number of positive and negative particles undergoing inelastic nuclear interactions. In the region from 1.8 to 22 Bev/c about 3% of the particles carry a negative charge. These are presumably all pions. The ratio N_{π^+}/N_{π^-} was determined at 720 Mev/c to be 0.90 ± 0.15. Assuming that this ratio does not change it is concluded that pions constitute 6 ± 2% of all nuclear active particles in the region of 1.8 to 22 Bev/c. The experiment was not able to measure the number of K-mesons, protons, and deuterons above 2 Bev/c. (TTT)

33666 CONCERNING THE PHYSICS OF HIGH ENERGY NEUTRINOS IN COSMIC RAYS. I. M. Zheleznikh, G. T. Zatsepin, V. A. Kuz'min, and M. A. Markov. Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 738-41(June 1962). (In Russian)

The problem of detecting neutrinos in cosmic rays is discussed. It is pointed out that such observations open a new field of experimental physics, i.e., that dealing with high energy neutrinos. Results obtained in such endeavors could prove quite fundamental for theories concerned with elementary particles. There is at present an insufficient amount of data for the complete understanding of weak interactions. Experiments are proposed for the solution of the following problems: the values of the critical impulses for the neutrino-baryon and neutrino-lepton interactions; existence of an intermediate boson; the identity of the electron neutrino and the muon neutrino; and existence of a direct interaction of the type (ve)(ve). (TTT)

33667 A STUDY OF VARIOUS RADIATIONS DURING SPACE FLIGHTS OF SPUTNIKS, SPACE SHIPS AND ROCKETS. P. V. Vakulov, S. N. Vernov, E. V. Gorchakov, Yu. I. Logachev, V. E. Nesterov, A. G. Nikolaev, N. F. Pisarenko, I. A. Savenko, A. E. Chudakov, and P. I. Shavrin (Moscow Univ. and Lebedev Physics Inst., Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 758-81(June 1962). (In Russian)

Data are presented on various radiation zones observed during the flights of the 3rd sputnik (launched May 15th, 1958, 1881 km apogee and 226 km perigee), the 2nd space ship (Aug. 19 to 20, 1960, 339 km apogee and a 306 km perigee), the 3rd space ship (Dec. 1 to 2, 1960, 265 km apogee and a 187.3 km perigee), and the space rocket launched toward Venus on Feb. 12th, 1961. A radiation belt of electrons was detected at a height of 320 km above the earth's surface from the bremsstrahlung radiation determined on Geiger-Mueller and scintillation counters. Conjugate zones in the Northern hemisphere were linked with corresponding zones in the Southern hemisphere. The position of the electron belt has remained relatively constant for about two years. The electron spectrum does not vary significantly. A count rate of >3.6 counts cm^{-2} sec^{-1} was obtained in a Geiger-Mueller counter in the South Atlantic Ocean off the coast of Brazil. This high count rate was due to a magnetic anomaly in this region. An accurate distribution of cosmic ray intensity as a function of latitute

was obtained from a comparison of the counts of the scintillation counter and the count of the STS-5 gas-discharge counter. Thirty references are included. (TTT)

33668 MOMENTARY INCREASES IN THE INTENSITY OF THE NUCLEAR COMPONENT OF COSMIC RAYS, ASSOCIATED WITH SOLAR ACTIVITY, AND A STUDY OF RADIATION INTENSITY AT HEIGHTS OF 200 TO 300 KM. V. L. Ginzburg, L. V. Kurnosova, V. I. Logachev, L. A. Razorenov, and M. I. Fradkin (Lebedev Physics Inst., Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 782-98(June 1962). (In Russian)

Two independent Cherenkov counters were installed on board the second deep-space rocket, and were used to detect heavy nucleons moving at relativistic speeds. During the flight more than 100 nuclei were counted with $Z \geq 15$, over 3000 with $Z \geq 5$ and about 30,000 with $Z \geq 2$. On Sept. 12th, 1959, at 11 hours and 27 min world time, an increased count was observed for 17 min; 512 nuclei with $Z \geq 2$ were counted. The increase in nucleons with $Z \geq 15$ was a factor of 11.8 higher than ordinary. Other momentary increases in count rate were observed on Sept. 12th, 1959, at 12 hours and 57 minutes. The intensity of nucleons with $Z \geq 15$ increased by a factor of 6, but the count rate for nuclei with $Z \geq 2$ and $Z \geq 5$ did not increase. These high count rates were definitely related to chromospherical solar outbursts observed at these same intervals. During the flights of the second and third space ships (Aug. 19 to 20, 1960, and Dec. 1 to 2, 1960, respectively), the count rate of charged particles in space was determined as a function of latitude on a telescope of gas-discharge counters. The average global counts of charged particles at the geomagnetic equator and at geomagnetic latitudes of 60 to 70° were 1.36 and 3.3 particles cm^{-2} sec^{-1} respectively. The count of cosmic ray nucleons was about 0.2 at the equator and 1 to 2 particles cm^{-2} sec^{-1} in the region of high latitudes. Lines of equal count rates are shown over the earth's surface. Two anomalous regions were found off the coast of Brazil and in the South Atlantic Ocean. Apparently, regional magnetic anomalies have a substantial effect on the flow of charged particles at heights of 200 to 300 km. An attempt was made to relate the count rate with the height above the earth. (TTT)

33669 COSMIC RAY VARIATIONS AND ELECTROMAGNETIC CONDITIONS NEAR THE EARTH. VARIATIONS IN CORPUSCULAR FLUXES IN INTERPLANETARY SPACE. L. I. Dorman. Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 799-807(June 1962). (In Russian)

Cosmic ray variations may be due to changes in meteorological factors (temperature and pressure of the atmosphere), geomagnetic threshold, and primary flux. The cosmic ray intensity undergoes periodic changes with time (11 year, annual, 27 day, daily, and semidiurnal), and nonperiodic changes (a decrease during a magnetic storm, and an increase with a solar flare). The geomagnetic minimum is not symmetric with respect to the earth's axis, but is closer to the earth in the direction of the sun. The orbital motion of the earth around the sun results in a diurnal variation with a cosmic ray maximum at 6 hours in the morning. In periods of high sun-spot activity, the radial plasma flux from the sun (solar "wind") gives a cosmic ray maximum at noon. The effect of inhomogeneous magnetic field, and diffusion of particles from outer space are considered briefly. Thirty-two references are given. (TTT)

33670 SOME RESULTS OF AN INVESTIGATION OF COSMIC RAY VARIATIONS. A. I. Kuz'min, G. F. Krymskii, G. V. Skripin, N. P. Chirkov, G. V. Shafer, and Yu. G. Shafer (Yakuts Affiliate, Siberian Division of the Academy of Sciences, USSR). Izv. Akad. Nauk SSR, Ser. Fiz., 26: 808-17(June 1962). (In Russian)

A decrease in the intensity of the penetrating component (μ-mesons from intermediate π-mesons) of cosmic rays was observed at all depths (7, 20, and 60 m water equivalent), when cosmic ray measurements were taken during a cyclone (10 separate instances). Diurnal maxima in the morning and evening hours were investigated. Magnetic disturbances caused the maxima to appear at an earlier time. During periods of magnetic storms, a decrease in cosmic ray intensity was observed in 26 cases. The neutron and meson components of the cosmic rays do not change in composition during the magnetic storm. From Jan. 1957 to Dec. 1960, ten cosmic ray outbursts were observed during period of magnetic storms. A typical energy spectrum is presented. The present theories cannot explain all the cosmic ray variations that were observed. (TTT)

33671 THE SPECTRUM OF μ-MESONS AT SEA-LEVEL, AND THE MECHANISM FOR THE GENERATION OF μ-MESONS IN THE REGION OF ENERGIES OF $E_\mu > 10^{11}$ ev. D. D. Krasil'nikov (Yakuts Affiliate, Siberian Div. of the Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 818-22(June 1962). (In Russian)

Spectra of ionization collisions of μ-meson-origin near sea level were observed in high-pressure chambers installed at many sites in the USSR and abroad. The hard component of cosmic rays was detected continuously on a "Model C Carnegie" (10.5 cm lead shielding) so that the results could be compared with those of Lange, and so that the distribution of collisions with height could be obtained. The data showed that about 60% of the high-energy collisions were of μ-meson origin. The spectra of collisions of μ-meson origin are presented in the form $b\,(>n_{pb}) = An_{pb}^{-\gamma'}$ cm^{-2} sec^{-1}. Here A is 2.3×10^{-2}, γ' is 2.08, and n_{pb} is the number of cascade shower particles in the lead. A significant part of the μ-mesons having energies $E_\mu > 2 \times 10^{11}$ ev are formed directly from the usual $\pi \rightarrow \mu$ transition. (TTT)

33672 A CONTINUATION OF THE STUDY OF THE PARTICLE SPECTRUM AND OF THE ATMOSPHERIC EFFECTS OF LARGE PARTICLE SHOWERS NEAR SEA LEVEL. D. D. Krasil'nikov, N. N. Efimov, M. A. Nifontov, and F. K. Shamsutdinova (Yakuts Affiliate, Siberian Div. of the Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 823-30(June 1962). (In Russian)

A continuous determination of the size of large particle showers in the region of $10^4 < N < 10^8$ particles was carried out at five sites near Yakuts by coincidence counting with banks of Geiger-Mueller tubes. The differential particle spectrum of the vertical intensity of the particle shower was assumed to be of the following form: $K(N)\,dN \sim N^{-x-1}\,dN$, where x is 1.4 for $N < 2 \times 10^5$ and 1.7 for $N > 2 \times 10^5$. With increasing size of the particle shower, the angular distribution of the particles became steeper. The function for the spacial distribution of shower particles $\phi(r)$ was assumed to be independent of the size of the shower and was taken in the following form: $\phi(r) = 1.84 \times 10^{-6}\,r^{-1}$ for $r < 10$ m, $\phi(r) = 2.21 \times 10^{-3}\,r^{-1} \exp(-r/55)$ for $10 < r < 100$ m, and $\phi(r) = 0.57\,r^{-2.6}$ for $r > 100$ m. These formulas were verified for four different distances of separation (3.8, 40, 57, and 80 m), and for three different areas of the groups of counters (1.0, 0.5, and 0.17 m^2). An expected barometric correction was calculated at a constant value for the range of the particle $\lambda_N = 180$ g cm^{-2}, and the expected pressure correction was compared with the experimental value for various sizes of particle showers. The range of the absorption of a shower decreased from $\lambda_{ab} =$

130 g cm^{-2} for a shower having $\bar{N} < 5 \times 10^4$ particles to $\lambda_{ab} = 82$ g cm^{-2} at $\bar{N} > 10^6$ particles. The particle shower changed in character at energies of 10^{14} to 10^{15} ev. The changes may be due to a higher content of heavy nuclei in the composition of the primary particles at energies of $E_0 > 10^{15}$ ev, or to a variation in the composition of the secondary particles. (TTT)

33673 DETERMINING LOCAL CONCENTRATIONS OF CHARGED PARTICLES IN THE IONOSPHERE AND INTERPLANETARY SPACE METHODS USED ON SOVIET ROCKETS AND EARTH SATELLITES AND SOME RESULTS OBTAINED. K. I. Gringauz (Radio Technical Inst., Academy of Sciences, USSR). J. Brit. Inst. Radio Engrs., 22: 419-24(Nov. 1961).

Electron concentration determinations in the ionosphere by radio wave dispersion measurements using transmissions from rockets are discussed with reference to the results obtained by various workers. Charged particle trap experiments carried on satellite and space probes are also described, and some conclusions are reached regarding the distribution of charged particles in the sunlit part of the Earth's gas envelope. (auth)

Criticality Studies

33674 AN APPROXIMATION FORMULA FOR CALCULATING THE GEOMETRIC PARAMETER OF ARBITRARILY CHOSEN HOMOGENEOUS BODIES. V. K. Bogatyrev. At. Energ. (USSR), 13: 68-70(July 1962). (In Russian)

The criticality of an arbitrarily chosen body was estimated by G. Stuart (J. Appl. Phys., 27: 527 (1956) No. 11) by means of the variation principle using a complex volume integration; the method developed by V. G. Zagrafov (Atomnaya Energiya, 8: 23 (1960) No. 1) may be used only if the dimensions of the system are of the order of the mean free path of the neutrons. This latter method was further improved by using a formula based on the assumption of the existence of a point having a maximum value of the neutron flux. To each body angle $d\Omega$ from this point there is a corresponding radius vector $r(\Omega)$ which serves as the measure of the distance from the point with the maximum neutron flux to the boundary of the body. The geometric parameter $\varkappa$ of a given homogeneous body is given by $\varkappa = 1/4 \int_\Omega [d\Omega/r(\Omega)]$. Computational errors of calculations carried out with this equation were found to be less than 6%. Although no strict proof was derived, correlating the results with the diffusion equations, the formula was found useful for practical calculations. (TTT)

33675 USE OF THE ALBEDO METHOD FOR STUDYING THE INTERACTION OF SUBCRITICAL SYSTEMS. V. K. Bogatyrev. At. Energ. (USSR), 13: 70-2(July 1962). (In Russian)

The interaction of subcritical systems having spherical and cylindrical geometry in air may be defined by means of the albedo method if each of the interacting systems is close to the critical state. The single-group diffusion approximation of the albedo may be simplified to the form $\gamma = 1 + (4D)/(\Delta r)$ where D designates the diffusion coefficient, r the radius of the sphere or the cylinder, and Δr the difference between actual and critical radii. If the incident flux does not have a spheric symmetry, the neutron reflection will be anisotropic; if the sphere is nearly critical, then the reflected flux will be close to the spherically symmetrical flux. The conditions of anisotropy were mathematically derived. The parameter γ is defined as the coefficient of neutron reflection by a separate body and also as the mean cosine of the reflection angle and is considered an important value for determining interactions between subcritical systems. Interacting bodies must decrease rapidly with increasing radii of the individual bodies if the geometric similarity between these bodies is maintained. In case of interaction, the neutrons penetrate into the multiplying medium to a depth corresponding to the length of the mean free path and thus only a surface layer of the multiplying material participates in the multiplication. (TTT)

33676 MEASURING EFFECTIVE DELAYED-NEUTRON FRACTIONS. Thomas F. Ruane (Knools Atomic Power Lab., Schenectady, N. Y.). Nucleonics, 20: No. 10, 94; 96; 98(Oct. 1962).

The effective delayed-neutron fraction β_{eff} of a reactor may be measured by substituting poison for a small fraction of fuel and measuring the resulting reactivity change. The theory of this substitution method is given; it is important to match absorptions in the fuel and poison. With this method, β_{eff} of the PMA-4D assembly was found to be 0.0079, in excellent agreement with calculations. (D.L.C.)

Elementary Particles and Radiations

33677 (AAEC/TM-123) THE TRACKING OF PARTICLES THROUGH A HEXAGONAL LATTICE OF HOMOGENEOUS CIRCULAR RODS FOR MONTE CARLO APPLICATIONS. J. J. Thompson (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Jan. 1962. 13p.

A description is given of a method used to determine the co-ordinates of successive collision points in a problem associated with the diffusion of neutrons through a hexagonal lattice of circular rods. The basic geometrical relations are discussed and a computer flow chart is included. (auth)

33678 (AFOSR-1887) ON THE $\mu \rightarrow e + \gamma$ DECAY. Scientific Note No. 11. D. Fiamm (Vienna. Universitat. Institut fur Theoretische Physik). Oct. 20, 1961. Contract AF61(052)-265. 6p. (AD-272437)

A phenomenological diagram for the meson decay containing a virtual Pi-meson was calculated and by comparison with experimental data an upper limit for the cut off was found, which is of the same order of magnitude as the one obtained by Ioffe for another diagram containing only leptons. (auth)

33679 (BLG-72) L'INTERACTION ENTRE DEUX NUCLEONS. (The Interaction Between Two Nucleons). H. Pollak (Brussels. Centre d'Etude de l'Energie Nucleaire). Feb. 1962. 50p.

The two body matrix element, $< n_1\ l_1\ j_1,\ n_2\ l_2\ j_2;\ J \mid V\ (\mid \bar{r}_1 - \bar{r}_2 \mid)\{w + mP_x + hP_\tau + bP_\sigma\} \mid n_3\ l_3\ j_3,\ n_4\ l_4\ j_4;\ J >$ can be calculated by various methods as readily for the angular as for the radial part. All these methods are examined in view of their possibilities for programming on a computer. (auth)

33680 (BNL-6233) HYPERON PRODUCTION BY 3.25 Bev/c ANTIPROTONS IN HYDROGEN. C. Baltay, E. C. Fowler, et al. (Yale Univ., New Haven); and B. B. Culwick et al. (Brookhaven National Lab., Upton, N. Y.). [1962]. Contracts [AT(30-2)-Gen-16 and AT(30-1)-1349]. 11p.

Preliminary results are presented on hyperon-anti-hyperon production in proton-anti-proton collisions at 3.25 Bev/c. The exposure consisted of approximately 40,000 pictures taken in 20 in. liquid H_2 bubble chamber. All events with less than 6 prongs at the production vertex

and exhibiting either charged or associated neutral V's were scanned for and analyzed by the Brookhaven and Yale reconstruction and kinematic fitting programs. Data and information are included on observed hyperon pairs, production of $\Lambda\bar{\Lambda}$ pairs, production of neutral $\Lambda\Sigma$ pairs, production of $\bar{\Sigma}^{+}\Sigma^{+}$ pairs, and $\bar{Y}Y$ production in more than two body final states. (J.R.D.)

33681 (BNL-6234) MULTI-PION ANNIHILATIONS OF 3.25 Bev/c ANTIPROTONS IN HYDROGEN. T. Ferbel, J. Sandweiss, H. D. Taft (Yale Univ., New Haven); M. Gailloud, T. W. Morris (Brookhaven National Lab., Upton, N. Y.); R. M. Lea (City Coll., New York); and T. E. Kalogeropoulos (Columbia Univ., New York). [1962]. Contracts [AT(30-2)-Gen-16 and AT(30-1)-1349]. 24p.

A study was made of 3.25 Bev/c antiproton-proton interactions which produce 4 charged pions. A 20 in. liquid H_2 bubble chamber was used. A summary of results obtained in a preliminary sample comprising 782 4 prong events which were measured and analyzed are presented. (J.R.D.)

33682 (BNL-6332) ELECTRON-ATOM SCATTERING AND NUCLEON-NUCLEUS SCATTERING—AN ANALOGY. Murrey D. Goldberg (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract [AT(30-2)-Gen-16]. 6p.

An analogy is drawn between low-energy nucleon-nucleus scattering and low-energy electron-atom scattering. Proper scaling indicates that the Ramsauer resonances in electron scattering are analogous to the "size" resonances of nucleon scattering. Total cross sections, angular distributions, and spin polarizations are calculated. An imaginary potential is introduced, and its consequences for direct electron-atom interactions are discussed. (auth)

33683 (MURA-648) TABLES OF RELATIVISTIC AND MAGNETIC PARAMETERS. M. E. Ellis (Midwestern Universities Research Assn., Madison, Wis.). Aug. 3, 1962. Contract AT(11-1)-384. 135p.

The total energy E, β, γ, momentum p, and the product $B\rho = (cp/e)$ are given in tabular form for protons of kinetic energy from 0 to 1000 Bev and for electrons of kinetic energy from 0 to 100 Bev. (auth)

33684 (NP-12134) APPLICATION OF THE CLASSICAL SELFCORRELATION FUNCTION TO DETERMINE THE SLOW NEUTRON SCATTERING CROSS-SECTION OF FREE MOLECULES. Krzysztof Parlinski (Polish Academy of Sciences. Inst. of Nuclear Physics, Krakow). June 1962. 8p.

A classical selfcorrelation function is found for an atom in the molecule by considering the translation of the free molecule, its rotation and oscillation. The Krieger-Nelkin formula for the differential cross section of incoherent neutron scattering by molecules is derived from the correlation. (auth)

33685 (NP-12135) THE TOTAL SCATTERING CROSS-SECTION OF SLOW NEUTRONS IN GASEOUS H_2S. N. Tubbs, U. Sagan, H. Rzany, J. A. Janik, and J. Janik (Polish Academy of Sciences. Inst. of Nuclear Physics, Krakow). July 1962. 6p.

In view of the difference between Heinloth's measured values for the neutron cross-sections of protons in water vapor and those predicted by the Krieger-Nelkin theory, measurements with gaseous H_2S were made. Results for this similar molecule show a smaller divergence from the theoretical values. (auth)

33686 (NYO-10244) RELATIVISTIC INVARIANCE AND HAMILTONIAN THEORIES OF INTERACTING PARTICLES. D. G. Currie, T. F. Jordan, and E. C. G. Sudarshan (Rochester, N. Y. Univ.). June 4, 1962. Contract AT(30-1)-875. 102p.

Relativistic invariance may involve two different theoretical postulates: symmetry of the theory under the relativistic transformation group reflecting the invariance of physical laws under changes of reference frame, and explicit transformation properties or manifest invariance of certain quantities. A Lie group formalism, for classical or quantum mechanics of particle variables or fields, is introduced and used to show how symmetry under the Lorentz (or Galilei) group is provided by ten generators satisfying the characteristic Lie bracket equations. For a classical mechanical theory of a fixed number of particles, the Lorentz transformation formula is assumed for the coordinates of the space-time events that comprise the world lines of the particles as defined by their positions as a function of time. This assumption of manifest invariance is expressed in terms of equations involving the Poisson brackets of the canonical position coordinates with the generators of the Lorentz group. For a theory of two particles it is shown that the only generators satisfying these latter equations plus the Poisson bracket equations characteristic of Lorentz symmetry are those descriptive of free particle motion; the combined assumption of Lorentz symmetry and Lorentz transformation of particle positions rule out any interaction. (auth)

33687 (PAN-326/VI) MULTIPLE MESON PRODUCTION IN 7 Gev π^{-}-CARBON NUCLEUS COLLISIONS. Oleg Czyżewski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). May 1962. 19p.

An investigation of 101 stars, representing central collisions of π^{-}-mesons at 7 Bev/c with C nuclei in a propane bubble chamber is reported. A central collision means the collision with two or more protons engaged. The number of secondary mesons increases with increasing number of engaged protons and is in average greater, than in similar energy π meson–nucleon collisions. Results were compared with the tunnel and the cascade model of collision. The cascade model is in much better agreement with the experimental results. (auth)

33688 (PAN-327/VI) π^{0}-MESON PRODUCTION IN 8,4 Gev/c π^{-}-XENON NUCLEUS COLLISIONS. Oleg Czyżewski and Jerzy Łoskiewicz (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). May 1962. 15p.

The inelastic interactions of 8,4 Bev/c π^{-}-mesons with Xe nuclei in the Xe bubble chamber were investigated. The energy spectrum and the angular distribution of secondary photons were measured. The possibility of correlating photon pairs into individual π^{0}-mesons is shown. The energy spectrum of π^{0}-mesons consists of a low energy part up to 0.6 Bev and a high energy tail. The mean transverse momentum $(p_T)_{\pi^0} = (0.36 \pm 0.04)$ Bev/c. (auth)

33689 (PAN-328/VI) EMISSION OF THE HEAVY PARTICLES IN THE INTERACTIONS AT ENERGIES GREATER THAN 10^{9} ev. Jan A. Danysz (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). May 1962. 11p.

The angular distribution and energy spectrum of heavy particles emitted in the interactions of 7 Bev/c π^{-} with C-nuclei in propane bubble chamber were investigated. The forward-backward asymmetry of emitted protons increases with increasing energy of these protons at 7 to 80 Mev. The results were compared with several emulsion experiments up to the highest cosmic ray energies. It was observed that the emission of heavy particles of energy higher than ~20 Mev depends very little on the primary energy. The experi-

mental data are in qualitative agreement with the predictions of the cascade theory. (auth)

33690 (PAN-329/XVII) ČERENKOV RADIATION IN THE Co^{60} GAMMA IRRADIATION UNIT. Włodzimierz Kołos and Stanisław Kosek (Polish Academy of Sciences, Inst. of Nuclear Research, Warsaw). May 1962. 13p.

During gamma irradiation of water and benzene a bluish-white luminescence was observed, whose intensity depends strongly on the direction of observation and to a much smaller degree on the irradiated medium. Assuming that the Cherenkov radiation was observed the relative intensities of the luminescence were computed for water and benzene in the spectral regions 3000 to 6000 Å and 3000 to 10000 Å. The agreement between theoretical and experimental results proves the Cherenkov nature of the radiation. (auth)

33691 (TID-16625) OFF-THE-ENERGY-SHELL EFFECTS IN NUCLEON–DEUTERON SCATTERING. K. L. Kowalski and D. Feldman (Brown Univ., Providence). [May 15, 1962]. Contract AT(30-1)-2262. 8p.

An investigation is made to inquire whether or not off-the-energy-shell (FES) effects have any significance on nucleon-nucleon interactions. For the sake of simplicity, possible Coulomb effects are neglected and the S state of the deuteron is the only state considered. The matrix elements calculated in the FES approximations are employed in the computation of the cross sections and polarizations of nucleon-deuteron scattering at 150 Mev. The results are compared with the Chew and linear approximations. The plotted curves indicate that the corrections of the FES approximations are significant. (N.W.R.)

33692 (TID-16687) SINGLE NEUTRON TRANSFER REACTIONS OF Co^{59}. A. M. Friedman (Argonne National Lab., Ill.). June 1962. Contract [W-31-109-eng-38]. 6p. (UAC-6507)

The residual target products were studied in the case of Co^{59} single neutron reactions to determine those reactions that result in transfers to bound state. The Co^{59} was rolled in foils and irradiated using H^2, He^4, C^{12}, N^{14}, and O^{16} beams. It was found that at 3 to 10 Mev per nucleon, the cross sections for all cases except the (He^4, He^4, n) and the (H^2, H^4) reactions could be fit by the expression $\log \sigma = \alpha e^{-\beta/E}$ where α and β are constants for each projectile and E is the center of mass energy per nucleon of the beam. Data on cross sections for formation of Co^{58} and Co^{60} are included. (J.R.D.)

33693 (TID-16725) INTERFERENCE PHENOMENA OF NEUTRAL K MESONS. R. G. Sachs (European Council for Nuclear Research, Geneva and Wisconsin. Univ., Madison). Aug. 24, 1962. Contract [AT(11-1)-30]. 45p.

A systematic theoretical treatment of various interference phenomena of the neutral K mesons is presented. The phenomena were treated for the extreme case that CPT, CP, and T invariance are all violated. Consequences of these invariances were derived. The relationships imposed on the propagators by the invariance conditions and a general analysis of the K_1, K_2 problem in terms of the propagator are given. The space-time development of a K^0 beam was treated and this was applied to the general problem of K^0 decay. A discussion of the 2π decay mode and leptonic modes is included. The scattering and regeneration of K_1 and K_2 mesons are discussed with particular reference to the regenerative forward scattering suggested by M. L. Good as a method for measuring the K_1-K_2 mass difference. (auth)

33694 (TID-16727) CALCULATION OF REDUCED WIDTHS FROM RESONANT SCATTERING OF PROTONS BY A DIFFUSE POTENTIAL. J. P. Schiffer (Argonne National Lab., Ill.). June 1962. Contract [W-31-109-eng-38]. 4p. (UAC-6505)

An investigation concerning the effect of a diffuse surface on extracting nucleon reduced widths in bound nuclear energy levels by use of the optical-model codes is described. Using this method, the well depth was adjusted so that the $d_{\frac{3}{2}}$ level would occur at various energies of the incident proton. Interpolating a graph of such calculations at the 1.75 Mev level, it is found that the $d_{\frac{3}{2}}$ scattering resonance has a width of 57 kev. From this it appears that this is a good particle state, as is expected from the shell model. (J.R.D.)

33695 (TID-16745) RECOIL STUDIES OF NUCLEAR REACTIONS INDUCED BY HIGH-ENERGY PROTONS AND ALPHA PARTICLES. Lester Winsberg (Argonne National Lab., Ill., California. Univ., Berkeley. Lawrence Radiation Lab., and Illinois. Univ., Urbana). June 1962. Contract [W-31-109-eng-38]. 8p. (UAC-6540)

The excitation functions and recoil energies of the reaction products are reported for the interaction of protons and alpha particles with Ta, Au, and Bi in the production of Tb^{149}. (J.R.D.)

33696 (TID-16746) THE (d,p) REACTION AT 21.4 Mev DEUTERON ENERGY. J. L. Yntema (Argonne National Lab., Ill.). June 1962. Contract [W-31-109-eng-38]. 4p. (UAC-6524)

Experiments to determine whether or not deuteron angular momentum values (l) can be distinguished unambiguously at higher energies are described. Preliminary experiments were conducted on the reactions $Ti^{49}(d,p)Ti^{50}$, and $Ti^{50}(d,p)Ti^{51}$ at deuteron incident energies of 21.4 Mev. The $Ti^{49}(d,p)Ti^{50}$ reaction at 1.56 Mev was also studied. An analysis of results is included. (J.R.D.)

33697 (TID-16749) SENIORITY MIXING IN $1f_{\frac{7}{2}}$ NUCLEI. B. Zeidman and R. D. Lawson (Argonne National Lab., Ill.). June 1962. Contract [W-31-109-eng-38]. 3p. (UAC-6519)

For target nuclei in which the $1f_{\frac{7}{2}}$ neutron shell is filling, it was found that more than one prominent l = 3 transition exists in neutron pickup reactions. On the basis of all the data, it can be shown that ascribing each of the peaks to a different orbit does not provide a satisfactory explanation of the results. Parameters for use in a reasonable analysis by seniority classification is given. (J.R.D.)

33698 (TID-16811) A PENCIL BEAM FOR USE WITH LIQUID H_2 "FINGER" TARGETS. Internal Report No. 103. R. E. Lanou, Jr. (Brown Univ., Providence). Aug. 20, 1962. Contract [AT(30-1)-2262]. 21p.

A negative pion beam was designed and used for experiments utilizing a high-Z bubble chamber equipped with a hydrogen internal target (beam finger). Design requirements are listed. Performance is discussed in terms of cross section and trajectories, momentum, beam intensity, and contamination by photons, muons, and electrons. (M.C.G.)

33699 (UCRL-10216) REGGE TRAJECTORIES FOR YUKAWA POTENTIALS. Akbar Ahmadzadeh, Philip G. Burke, and Cecil Tate (California. Univ., Berkeley. Lawrence Radiation Lab.). May 24, 1962. Contract W-7405-eng-48. 25p.

The trajectories of the poles for an attractive Yukawa potential are described. A repulsive potential is also considered along with the effect of a hard core which dominates the centrifugal barrier at the origin. Other discussion is included concerning the case of potentials that can

be represented by a superposition of Yukawas, for which certain relations between the energy at which a Regge curve can cross the real l-axis and the potential strength. These crossing points are shown to be indeterminacy points in the S-matrix, which play a vital role in the behavior of the Regge trajectories in the left-hand λ plane (where $\lambda = l + \frac{1}{2}$). (J.R.D.)

33700 (UCRL-10220) TEST OF ISOTOPIC SPIN CONSERVATION IN STRONG INTERACTIONS FROM AN EXPERIMENT LIMIT ON $\sigma(d + d \rightarrow He^4 + \pi^0)$. John A. Poirier and Morris Pripstein (California. Univ., Berkeley. Lawrence Radiation Lab.). May 25, 1962. Contract W-7405-eng-48. 11p.

A search for the reaction $d + d \rightarrow He^4 + \pi^0$ was conducted to test the validity of isotopic spin (I-spin) conservation. A result based on data analysis sets an upper limit for the differential cross section of this reaction, in the center-of-mass system, of $(d\sigma)/(d\Omega)$ $(d + d \rightarrow He^4 + \pi^0) < 1.5 \times 10^{-34}$ cm^2/sr. It is concluded that I-spin is at least 99.6 conserved. An upper limit for the reaction $d + d \rightarrow He^4 + \gamma$ was also obtained. The upper limit obtained for this reaction is $(d\sigma^{cm})/(d\Omega)$ $(d + d \rightarrow He^4 + \gamma) < 3.5 \times 10^{-34}$ cm^2/sr. (J.R.D.)

33701 (UCRL-10225) K^+-NUCLEON INTERACTION. III. PION PRODUCTION BY K^+ MESONS ON HYDROGEN AND DEUTERIUM. H. F. Fisk, H. K. Ticho, D. H. Stork (California. Univ., Los Angeles) and W. Chinowsky, G. Goldhaber, S. Goldhaber, T. F. Stubbs (California. Univ., Berkeley. Lawrence Radiation Lab.). June 1, 1962. Contract [W-7405-eng-48]. 17p.

Mesons (K^+) interacted in a bubble chamber at 642 Mev/c. A total of 40,000 photographs were taken. Each two-prong event in hydrogen was analyzed for kinematical consistency with elastic K^+ scattering ($K^+ + p \rightarrow K^+ + p$) and the inelastic pion production reactions ($K^+ + p \rightarrow K^+ + p + \pi^0$, $K^+ + p \rightarrow K^+ + n + \pi^+$, and $K^+ + p \rightarrow K^0 + p + \pi^+$). In each case, the fit of the measured quantities to the kinematics of pion elastic scattering and single pion production was also examined. Studies were also made of the interactions of mesons (K^+) with deuterons. It was not possible to uniquely classify any events yielding only two charged particles. The total number of hydrogen events was 96. In deuterium there were 92 events, 69 of which were interactions with neutrons. Cross sections were calculated. Branching ratios consistent with a K-π interaction in the $T = \frac{1}{2}$ state were observed. (M.C.G.)

33702 (UCRL-10337) THE REACTION $K^+ + P \rightarrow K^+ + N^*_{33}$. W. Chinowsky, G. Goldhaber, S. Goldhaber, W. Lee, and T. O'Halloran (California. Univ., Berkeley. Lawrence Radiation Lab.). June 27, 1962. Contract W-7405-eng-48. 16p.

Studies were made of the interaction of K^+-mesons on hydrogen at 1.96 Bev/c. A total cross section of 18 ± 3 mb was obtained. If the events occurring from $M_{K\pi} = 860$ to 920 are ascribed to K^* production and $M_{P\pi} = 1180$ to 1290 are ascribed to N^*_{33} production, then out of 151 identified events 25 were in the "non-resonant" region, 78 were in the K^* region, 106 were in the N^*_{33} region, and 62 of these events are in the common K^* and N^*_{33} region. Therefore about half or more of the interaction appeared to go through the double resonant state. It is shown that K^* is a $T = \frac{1}{2}$ resonance. (M.C.G.)

33703 (AEC-tr-5232) APPARATUS FOR STUDIES ON CONDENSED SYSTEMS BY MEANS OF INELASTIC SCATTERING OF COLD NEUTRONS. M. G. Zemlyanov and N. A. Chernoplekov. Translated from p.409-14 of "Proceedings of Symposium on Pile Neutron Research in Physics, held in Vienna, October 17-21, 1960" (a publication of the International Atomic Energy Agency, Vienna, 1962. (STI/PUB/36(p.409-14)). 7p.

An experimental facility attached to the IRT-1000 reactor for studying the dynamics of condensed matter is described. The inelastic scattering of cold neutrons is the basis of the experimental measurements. (J.R.D.)

33704 RELATIVISTIC LEE MODEL AND INTERACTION REPRESENTATION. Wolfgang Kummer (Technische Hochschule, Vienna). Acta Phys. Austriaca, 15: 244-50 (1962). (In German)

It is shown that a Lee field model permits in an interaction representation very important simplifications to be made to the solutions to the equations to be solved for the scattering amplitude. Especially the linearity of the equations resulting makes the method for model calculations seem very promising. As an example the relativistic effective cross section of two scalar particles was calculated. (tr-auth)

33705 MOTION OF AN IMPURITY IN A BOSON FLUID. Lesser Blum (Facultad de Ciencias Exactas y Naturales, Buenos Aires). Anales Soc. Cienti. Arg., 173: No. 1 and 2, 10-16(Jan.–Feb. 1962). (In Spanish)

The interaction of a foreign particle in a Bose-Einstein medium was studied using a diagram method. An integral equation was obtained with a core of a series of operators which constitute a "cluster expansion." In the lower orders in the coupling constant, asymptotic integration gives formulas reported earlier (J. Phys. Soc. Japan, 16: 616 (1961)). The formulas deduced in the present study are only valid when the volume of the boson media approaches infinity. (tr-auth)

33706 s-WAVE PION-NUCLEON SCATTERING AND PION-PION INTERACTIONS. J. Hamilton, T. D. Spearman, and W. S. Woolcock (University Coll., London). Ann. Phys. (N. Y.), 17: 1-40(Jan. 1962).

Using a partial wave dispersion relation, it is shown how the low-energy s-wave π-N interactions can be separated into long-range and short-range parts. A survey of the errors and uncertainties in the method is given. The results show how s-wave π-N scattering can be resolved into four main constituents: core scattering; $T = 0$ and $T = 1$ π-π scattering; and rescattering. The conclusions on $T = 0$ and $T = 1$ π-π scattering are compared with experimental and theoretical data. (auth)

33707 CHIRAL SYMMETRIES. S. Coleman and S. L. Glashow (California Inst. of Tech., Pasadena). Ann. Phys. (N. Y.), 17: 41-60(Jan. 1962).

A study of chiral symmetries (symmetries involving γ_5) is presented. Two important varieties of chiral symmetry are examined in detail, viz. bound chiral symmetry and free chiral symmetry. All the possible free chiral symmetries are constructed, and representative examples of bound chiral symmetries are discussed. Certain theories are treated as special cases. (auth)

33708 ANALYSIS OF THE K^+-DEUTERIUM EXPERIMENTS. Erasmo M. Ferreira (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Ann. Phys. (N. Y.), 17: 159-75(Jan. 1962).

A discussion is presented of the K^+ meson-deuteron scattering, in terms of elementary two-particle processes. It is assumed that only S-waves contribute to the K^+-neutron interaction. Data on the charge exchange process $K^+d \rightarrow K^0pp$ are used, and seem to confirm this assumption. By the use of these data, two kinds of solutions are obtained for the scattering parameters in the isotopic spin

zero state of the K-nucleon system. Measurements of the cross section for the inelastic (nonexchange) process $K^+d \rightarrow K^+np$ may decide between the two groups of solutions. (auth)

33709 CHARGE-INDEPENDENCE IN K^--DEUTERIUM CAPTURE REACTIONS. Ramesh Chand and R. H. Dalitz (Univ. of Chicago). Ann. Phys. (N. Y.), 20: 1-19(Oct. 1962). (EFINS-62-24).

The effects of the $(K^-,\bar{K}^0)$ mass difference Δ, and of multiple scattering in the initial state, are discussed for K^--deuterium capture rates at zero energy. In contrast with the large distortions from charge-independence caused by Δ in K^--p capture processes, the ratio $(\pi^+ + \pi^-)/2\pi^0$ in K^--d capture is deviated only a small amount from the charge-independence value of unity. This result is caused partly by the dominance of I = 0 absorptive interactions. For direct Λ-production, the ratio $(\pi^-\Lambda p)/(\pi^0\Lambda n)$, which is unobservable, is distorted rather strongly by Δ. With a certain set of parameters, the effect of the multiple scattering is to modify the (π^+/π^-) ratio appreciably in the direction required by experiment. (auth)

33710 SOME CONSIDERATIONS ON THE RADIATIVE CORRECTIONS TO MUON AND NEUTRON DECAY. S. M. Berman and A. Sirlin (CERN, Geneva). Ann. Phys. (N. Y.), 20: 20-43(Oct. 1962).

The possibility of ambiguities in the regulator procedure used in the calculation of the radiative corrections to muon decay is discussed. It is pointed out that there is a particular gauge, namely the "Landau gauge," in which all the integrals are finite without regularization. The connection of some regulator methods with gauge invariance is discussed. A qualitative comparison is made between the corrections to μ decay with those corresponding to a "bare" neutron decay evaluated on the basis of the local V−A theory. It is pointed out that the leading term in the corrections to neutron decay is a "universal" contribution independent of the nature of the β coupling and the spin of the nucleus. The existence of this term is in fact independent of the presence or absence of ultraviolet divergences. The dependence of the corrections on the ultraviolet cutoff Λ is studied for the decay of a "bare" neutron. It is found that in the interval $0.3m_p \lesssim \Lambda \lesssim 1.8m_p$ the corrections to the lifetime of O^{14} vary from −1.2 to −2.2%. On the basis of Lorentz and gauge invariance some general expressions are derived for the form factors describing the interaction of two spin ½ particles with the electromagnetic field, in the case in which only one of the spinor fields is on the mass shell. These results are then used in a qualitative discussion of the pion cloud effects on the radiative corrections. Under some plausible assumptions it is found that the coefficient of the "universal" term is not affected by the structure effects originating from strong interactions. This result gives some indication that the point structure calculation may give the dominant contribution to these corrections. The effect of the possible existence of intermediate bosons is qualitatively discussed. Although a consistent description of these effects requires the theory of the electromagnetic interactions of spin 1 particles, which is not definitely established, these effects might eliminate the discrepancy between the calculated and experimental values of μ and β half lives if the mass of the intermediate boson turns out to be of the order of the K meson mass. (auth)

33711 LOW LYING STATES OF A SYSTEM OF INTERACTING BOSONS. Eugene P. Gross (Brandeis Univ., Waltham, Mass.). Ann. Phys. (N. Y.), 20: 44-60(Oct. 1962).

The ground state wave function and energy of a system of interacting bosons are studied. Attention is focused on the real function $S(x_1 \ldots x_N)$ defined by $\Psi = e^S$. S is written as a sum of intrinsic two-particle, three-particle, etc., functions. The functions are fully determined by matching intrinsic n-particle terms in the equation obeyed by S. The theory describes both close collisions and the interaction of sets of particles with the surrounding medium. Analysis of the procedure in terms of distribution functions reveals that a linearization of the generalized superposition approximation is the key feature. Excited states of the phonon roton type are found in the form $\Psi = Fe^S$, with F a fully determined sum of terms of different particle numbers. The wave functions are similar to those for actual liquid helium, but give a more detailed description of the excitations for the restricted situations where the theory applies. (auth)

33712 SOME THEOREMS CONCERNING THE MOTION OF AN ELECTRICALLY CHARGED PARTICLE IN A DIPOLE MAGNETIC FIELD. Ernest C. Ray (RAND Corp., Santa Monica, Calif.) and Joseph E. Kasper. Ann. Phys. (N. Y.), 20: 119-31(Oct. 1962).

Theorems are proved, related to the application to cosmic rays of the theory of motion of an electrically charged particle in a dipole magnetic field. In making the proofs, it is assumed that the so-called trajectories of the first and second kinds have certain properties in the large. These properties can be verified numerically and by series expansions in any particular case. (auth)

33713 ON COMPLEX ANGULAR MOMENTUM IN MANY-CHANNEL POTENTIAL-SCATTERING PROBLEMS. [PART] I. John M. Charap and Euan J. Squires (Univ. of California, Berkeley). Ann. Phys. (N. Y.), 20: 145-56 (Oct. 1962). (UCRL-10138)

A continuation of the S matrix for many-channel potential scattering problems with arbitrary spin, away from physical values of the angular momentum, is defined. It is shown that the scattering amplitude can be expressed as a sum over physical J values of a summand that is meromorphic in the entire finite J plane. (auth)

33714 THE SPECTRAL COMPOSITION OF γ-RADIATION FROM HOMOGENEOUS CYLINDRICAL SOURCES. A. V. Larichev, D. P. Osanov, and V. I. Popov. At. Energ. (USSR), 13: 145-51(Aug. 1962). (In Russian)

The γ spectrum of volume sources depends not only on the isotopic composition of the radioactive material but also on the dimensions of the source which may affect the absorption and multiple scattering phenomena. This effect is especially noticeable when the dimensions of the source exceed the mean free path of the primary radiation. This problem was studied experimentally by determining the spectral composition of radiation from large cylindrical sources with diameters of 50, 100, and 175 cm, a height of 100 cm, and a wall thickness of 2 mm. The stainless steel cylinders were filled with a $Co^{60}SO_4$ solution. A scintillation counter with a NaI(Tl) crystal was used for determining the angular spectrum distribution on the surface of the cylinder at certain distances from it. It was found that within 50 and 200 cm the shape of the spectrum distribution curve is practically independent from the distance and also from the dimensions of the source if they exceed 2 to 3 mean free path lengths of the primary quanta. Shielding materials change the shape of the curve; Pb absorbs the soft portion up to the 0.6 Mev level. Fe causes a similar although lesser distortion while the equivalent Al shield increased the amount of the scattered radiation. The atomic number thus affects primarily the shape of the low-energy portion of the spectrum. (TTT)

33715 FOCUSING OF RECOIL PROTONS FOR THE PURPOSE OF SEPARATING MONOENERGETIC RECOIL NEUTRONS. A. P. Senchenkov. At. Energ. (USSR), 13: 178-9(Aug. 1962). (In Russian)

Methods suitable for the separation of monoenergetic neutrons in the low-energy field are not applicable to intermediate-range neutrons. Use of recoil proton spectrometers present experimental difficulties because both the energy and the angular separation of the recoil protons must be undertaken; however, one of these conditions may be eliminated if all the protons and the associated neutrons of a given energy are collected in a single point. Under certain conditions, the energy of the scattered neutrons is independent from the energy of the remaining neutrons or the scattering angle. Calculation of these conditions allowed an intermediate-range neutron selector to be designed. The neutron beam is used to release the recoil protons, a portion of which is recorded in a coincidence chamber, indicating that a neutron of the given energy is emitted from the scatterer and may be used for studying radiative or fission capture phenomena. The chief advantage of the scheme is its "focusing" of the recoil protons by means of a single, perpendicular magnetic field. (TTT)

33716 ON THE PROBLEM OF THE BOUND STATE OF THREE NUCLEONS. V. F. Kharchenko (Kharkov State Univ.). Ukr. Fiz. Zh., 7: 582-92(June 1962). (In Ukrainian)

The bound state of a system of three nucleons is considered, the interaction between them being described by a non-local Yamaguchi potential. Neglecting the spins of the nucleons, Schroedinger's equation for the systems is reduced to a unidimensional integral equation. The equation was solved numerically by the iterational method. The binding energy was calculated, and the wave function was found for the bound state of the system. If the spins and isotopic spins of the nucleons are taken into account, Schroedinger's equation with a non-local Yamaguchi potential is reduced to a system of two unidimensional integral equations. The solution of the system of equations determines the binding energy of tritium. (auth)

33717 ANALYTICAL PROPERTIES OF PARTIAL WAVE SCATTERING AMPLITUDES OF CHARGED PARTICLES. I. S-WAVES. Yu. L. Mentkovskii (Inst. of Physics, Academy of Sciences, Kiev). Ukr. Fiz. Zh., 7: 593-601 (June 1962). (In Ukrainian)

The analytical properties of the s-amplitude of the scattering of charged particles were studied as a function of momentum on the entire complex plane. The amplitude of scattering is presented. It is shown over the entire open plane with a cut along the negative ray of the imaginary axis (except for point k = 0) that the function M (k) is a regular analytical function of momentum k. Its zeroes in the upper half-plane (except for the zero at the point k = 0) are purely imaginary, simple, and form a finite set. They correspond to the bound state of the system. The arrangement of an infinite, generally speaking, set of zeroes in the lower half-plane is not established. (auth)

33718 DEUTERON SPLITTING UNDER THE ACTION OF NUCLEAR FORCES. A. M. Korolev, B. D. Konstantinov, and V. I. Ovcharenko (Inst. of Physics, Academy of Sciences, Kiev). Ukr. Fiz. Zh., 7: 602-17(June 1962). (In Ukrainian)

The splitting of the deuteron is considered under the action of nuclear forces in the case when the state of the nucleus is unchanged during deuteron splitting. It is also assumed that both the proton and the neutron interact with the nucleus. Discussion is based on the theory of perturbations. The distortion of the deuteron wave function in the initial state, the wave function of the motion of the center of gravity, and the relative motion of the neutron-proton system in the final state were taken into consideration and a calculation was made of the matrix elements of the transition, and the complete and differential sections of the process d(np) were found. In view of the complexity of the expressions obtained for differential and complete sections of deuteron splitting, the sections were computed for the case of deuteron energies close to the threshold of the reaction ($2.3 \leq E_d \leq 4.65$ Mev). The results of the computation for the nucleus Ni^{58} are presented. The complete section in the deuteron energy range under consideration perceptibly increased with an increase in energy and at $E_d = 4.65$ Mev attained a considerable value (approximately 670 M barnes). The angular distribution of the protons is shown in respect to the neutrons escaping at $\Theta_p = 0$. The angular distribution corresponds to an energy of incident deuterons of 4 Mev and has a maximum at $\Theta_p = 0$ with a half-width of 75°. (auth)

33719 PARTICLE GENERATION AT THE VERY HIGH ENERGY REGION. V. S. Barashenkov and V. M. Mal'tsev. At. Energ. (USSR), 13: 221-7(Sept. 1962). (In Russian)

In view of the proposed construction of accelerators operating in the ten to hundreds of Bev energy region, the intensity of the particle beams generated in nucleon–nucleon and pion–nucleon collisions must be known. Neutrino and μ-meson fluxes are especially important for the study of weak interactions. There is at present no theory which could account for the multiple generation of particles by high-energy inelastic interactions. Data are available on charged and neutral π-mesons generated by p-p interactions at various kinetic energies, T, of the primary protons. Theoretical data at $T \leq 50$ Bev were computed on the basis of the Fermi theory. In addition to π-mesons, neutrons and π^0-mesons are also generated. The number of strange particles is low but it increases with increasing T. The calculations present difficulties at very high energies, $T > 50$ Bev. The probability of the formation of hyperon–antihyperon pairs must be estimated. At $T \gg 1$ Bev, the number of generated particles remains relatively constant, being independent from the nature of the particles colliding with the target nucleons. The neutral π-mesons from fast-particle collisions may decay into γ quanta, the corresponding charged particles decay into neutrino and μ-mesons. For more precise calculations, corrections must be made for the cascade processes taking place in the target material and more precise spectral data must be made available. (TTT)

33720 INTERMEDIATE VECTOR MESONS: ELECTROMAGNETIC PROPERTIES AND PRODUCTION CROSS SECTION. Myron Bander (Columbia Univ., New York). Dissertation Abstr., 23: 660-1(Aug. 1962).

The dynamics of free spin one bosons and their transformation properties under parity, time inversion, and charge conjugation were studied. Also the most general electromagnetic interaction, regardless of transformation properties under reflection groups, was set up and investigated in the non-relativistic limit. The formalism was applied to bosons which could be responsible for weak interactions, and the cross section for their production in the process $\nu + p \rightarrow \begin{pmatrix}\mu\\ e\end{pmatrix} + p + W$ (W is the boson) was calculated. The results are presented in graphic and tabular form.

33721 ELECTRIC AND MAGNETIC POLARIZABILITIES OF THE NUCLEONS AND PIONS. V. S. Barashenkov and H. J. Kaiser (Joint Inst. for Nuclear Research, Dubna, USSR). Fortschr. Physik, 10: 33-64(1962). (In English)

A number of experimental and theoretical papers have been devoted to the investigation of the electric and magnetic polarizabilities of nucleons. In the present paper, the results of these works are considered in detail.

Theoretical and experimental data indicate that the geometrical dimensions of the pion seem to be of the same order as those of the nucleon, which would seem to indicate that the pion would be polarized under the influence of an electromagnetic field. This point is discussed in detail. (J.S.R.)

33722 NEW EXPERIMENTAL DATA ON μ-MESONS. A. I. Alikhanian and A. O. Waisenberg. Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 698-701(June 1962). (In Russian)

The accumulated experimental data on μ-mesons was examined. The electromagnetic interactions of muons are discussed. The cross sections for the production of $\mu^+\mu^-$ pairs from high energy photons were found to agree, within experimental errors, with the predicted values. From the scattering of muons on nuclei the characteristic length, that enters into the muon formfactor, was found to be approximately 0.5 fermis. The gyromagnetic factor for the muon agrees to within 2% of the theoretical value. The weak interactions of μ-mesons were also considered. The experimental mean lifetime of the muon agreed with the calculated value and thus supported the existence of a universal weak interaction. The polarization of the muon at the time of $\pi \rightarrow \mu$ decay also agreed with that calculated from theory. The helicity of particles emitted in the decay, $\mu \rightarrow e + \nu + \bar{\nu}$, is also described. (TTT)

33723 SOME QUESTIONS CONCERNING THE GENERATION OF STRANGE PARTICLES. Z. Sh. Mandzhavidze and N. N. Roinishvili. Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 716-21(June 1962). (In Russian)

Data were determined concerning the production of heavy, unstable particles by cosmic rays. In all, 50 Λ^0, 42 θ^0, and 18 $\Sigma^\pm$ particles were observed in a Wilson chamber at a height of 1800 mm above sea level. The energy distributions were determined for particles produced in nuclear interactions occurring at energies of several tens of Bev. It was also found that the Λ^0 and $\Sigma^\pm$ particles had anisotropies in their angular distributions which were substantially greater than those for the θ^0 mesons. The perpendicular components of the momenta of the strange particles were compared with those of pions. From these comparisons it was concluded that the radius of the volume for the generation of strange particles is $\geq 0.37 \times 10^{-13}$ cm as contrasted to $\geq 0.64 \times 10^{-13}$ cm for pions. (TTT)

33724 A METHOD FOR THE INVESTIGATION OF NUCLEAR INTERACTIONS AT HIGH ENERGIES. V. A. Tumanyan (Physical Inst., Academy of Sciences, Armenian SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 728-33(June 1962). (In Russian)

The problem of identification of particles created in high-energy nuclear interactions is reviewed. This becomes increasingly difficult as the energy increases, and in cosmic rays the problem is even more complex than in the case of reactions from accelerator produced particles. A statistical approach is proposed. Highly relativistic secondary particles have a lifetime (even for very short lived strange particles) which is of the same order as the mean free path for strong interactions in solid materials. One may thus, statistically, speak of say the strangeness number, not for any one reaction product but for the whole interaction process of secondary particles. From this, information about the strangeness of the initiating particle may be deduced. Similar arguments are presented for a statistical determination of production cross sections for hyperons or nucleons, and for angular distributions. Pions are an exception because of the photon component in the decay. An example of such an analysis is given. Since the method requires that the secondary particles also undergo nuclear interactions, observations on a cloud chamber with lead plates are particularly suitable for interpretation by this statistical procedure. (TTT)

33725 TRANSVERSE MOMENTUM OF CHARGED Σ^+-HYPERONS PRODUCED BY 9 Bev PROTONS IN EMULSION. L. P. Dzhanelidze, N. I. Kostanashvili, G. I. Lebedevich, K. V. Mandritskaya, and O. A. Shakhulashvili. Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 734-7(June 1962). (In Russian)

Previous bubble chamber experiments showed that with 6.8-Bev π^--mesons the average transverse momentum of secondary K^0, p, λ^0 particles was ~400 Mev/c, whereas for $\Sigma^\pm$ this value was 577 Mev/c. An experiment was performed with 9 Bev protons impinging on an emulsion camera $10 \times 15 \times 4$ cm, consisting of 100 layers of emulsion. Along-the-track scanning was employed. The identification of the Σ-hyperons was obtained from their decay, the ionization of the tracks, and their multiple scattering. The error in the determination of the Σ momentum was about 15%. Twenty-two thousand tracks were followed and 42 hyperons were selected. The average transverse momentum was found to be $p_\perp = 327 \pm 14$ Mev/c. With corrections for the decay of the hyperons it is concluded that $p_\perp \leq 600$ Mev/c. This is not significantly different from the value of $p \sim 400$ Mev/c obtained for 6.8 Bev/c π^--produced Λ^0-hyperons. (TTT)

33726 CURRENT STATE OF NEUTRINO PHYSICS (POSITION PAPER). B. Pontecorvo. Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 737(June 1962). (In Russian)

The questions of neutrino physics are stated, both answered and unanswered ones, Qualitative as well as the more usual quantitative aspects of the weak interactions are examined. Interest is principally focused on those experiments in which the free neutrino appears, i.e., not decay processes. The main problems are: (1) Is the four fermion interaction fundamental, or is it mediated through the field of a vector boson? (2) Is the β-decay neutrino the same as the π-decay neutrino? (3) Is the neutrino-electron scattering process of first order in the weak interaction constant? Questions 1 and 2 can be answered with accelerators in the energy region >10 Bev, and intensity of 10^{10} to 10^{11} protons cm^{-2} $pulse^{-1}$. Question 2 can also be answered with an ~500 Mev accelerator, having a beam of ~1 ma. Question 3 can be answered with powerful reactions, or the 500 Mev high intensity accelerator. Experiments on the fundamental problem on the high-energy cutoff of the Fermi interaction ($\sigma_\chi E^2$) cannot be readily attacked with any accelerator now contemplated. (TTT)

33727 THE NEUTRINO AND ANTINEUTRINO IN FREE SPACE, AND THE DESIGN OF AN EXPERIMENT TO COUNT FAST ANTINEUTRINOS WHICH ARE GENERATED BY COSMIC RAYS IN INTERGALACTIC MATTER. V. M. Kharitonov (Physics Inst. of the Academy of Sciences, Armenian SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 742-5(June 1962). (In Russian)

The reaction cross section of a neutrino with matter is very small; $\sigma_0 = 1.1 \times 10^{-43}$ cm^2 for slow neutrinos and $\sim 10^{-37}$ cm^2 for fast neutrinos with an energy of ~1 Bev. The mean free path in intergalactic matter is $\sim 10^{22}$ years for slow neutrinos and $\sim 10^{21}$ years for fast neutrinos. The antineutrino is the only particle which can give direct proof of the existence of anti-worlds. Antineutrinos or neutrinos could be formed by the decay of an initial neutron cloud, by nuclear reactions taking place constantly in the stars, and by the interaction of cosmic rays with matter. If it is assumed that neutrinos and antineutrinos are emitted constantly from $p \rightarrow n$ and $n \rightarrow p$ reactions, and are not ab-

sorbed subsequently, the neutrino flux is given as $n_{\nu_e} \cong 2\ (10^{-6}$ to $10^{-4}\ \Delta_g T$ year). Here Δ_g is the average number of galaxies in a cube 10^6 light-years on a side, and T is the age of the universe. With a long time scale for the age of the universe ($T \sim 10^{10}$ years), the fast neutrino flux from cosmic rays is estimated at $\sim 10^4$ cm^{-1} (at $\sigma = 10^{-40}$ cm^2), and this flux can be counted with a detector having a volume of a few cubic meters at a count rate of (1 to 10) 10^{-2} events per day. An experiment is underway to measure the slow neutrinos emitted by the sun (expected flux is 10^{10} cm^{-2} sec^{-1}). It is estimated that a detector having a volume of 1 to 2 m^3 can pick up a flux of slow antineutrinos of 10^7 per cm^3-sec. The radioactive impurities in the detector must be reduced to $<10^{-10}$. It is estimated that the neutrino and antineutrino flux should be less than 10^{10} cm^{-2} sec^{-1}. A large Cherenkov counter placed 20 to 30 meters underground can be used to count the neutrinos passing through the earth (probability of absorption of an antineutrino on passing through the earth is $\sim 10^{-7}$ to 10^{-6}). (TTT)

33728 A METHOD OF DETECTING HIGH-ENERGY CHARGED PARTICLES. A. I. Alikhanyan, F. R. Arutyunyan, K. A. Ispiryan, and M. L. Ter-Mikaelyan (Physics Inst. of the Academy of Sciences, Armenian SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 746-51(June 1962). (In Russian)

The emitted radiation, which originates on passage of a high-energy particle through a medium, can be used to measure the energy of the particle. This emitted radiation is called resonance radiation. An expression was derived for the number of emitted photons in the interval of frequencies $d\omega$ on traversing 1 cm of lattice material (lengthwise to the change in periodicity). The frequency ω is measured in units of $\omega_{1\ min} = \lambda_1 r_e c\ (N_1 + \alpha N_2)$. Here r_e is the classical radius of the electron, c is the velocity of light, N_1 and N_2 are the number of electrons per 1 cm^3 for the first and second layers of atoms ($N_1 > N_2$), and $\lambda = \lambda_1 + \lambda_2$ is the combined thickness of the first and second layers of atoms ($\alpha = \lambda_2/\lambda_1$), or the period of the medium. The emitted radiation consists of a number of harmonics, and the particle energy is measured in units of E_{1h}, which is the threshold energy for the first harmonic at $\alpha = 1$. The energy loss by resonance emission is about 10^4 ev per 1 g cm^{-2}, and depends on the lattice spacing. The differential spectrum of the emitted quanta has a maximum at $\omega \cong 1.5\ \omega_{r\ min}$ for each harmonic r. With increasing energy of the initial particle, $\omega_{r\ min}$ does not change, but ω_{max} increases in proportion to E^2. The number of resonance quanta per 1 cm path-length of lattice material varies sharply with the energy of the particle. The high-energy particle and the resulting resonance quanta, which are formed in a layered material with a low atomic number such as Be, Al, or polyethylene, pass through a proportional gas counter filled with a heavy absorbing gas such as xenon to detect the γ quanta. The method is suitable for measuring particle energies from (E/mc^2) of 2×10^2 to 5×10^3. Corrections must be made for the number of γ quanta formed by δ electrons. (TTT)

33729 THE PASSAGE OF A FAST PARTICLE THROUGH A LAMINATED SUBSTANCE. G. M. Garibyan (Physics Inst. of the Academy of Sciences, Armenian SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 754-7(June 1962). (In Russian)

An expression was derived for the spectral density of the intensity of emitted, transition radiation that occurs on passage of an ultrarelativistic particle through a disk of thickness a. The dielectric constant of the medium is $\epsilon(\omega) = 1 - (\sigma/\omega^2)$, and $\sigma = 4\pi Ne^2/m$. The frequency of the transition radiation ω was plotted as a function of intensity for a beryllium disk ($\sqrt{\sigma} = 3.8 \times 10^{16}$) at values of $a = 10^{-1}$, 10^{-2}, 10^{-3}, and 10^{-4} cm. The energy values in terms of $(E/\mu c^2)$ for the particle generating the transition radiation were 10^1, 10^2, 10^3, 10^4, and 10^5. It is shown that in order to neglect the density of the plate, the distance b between the layer must satisfy the following condition: $b \gg (2v\Omega/\sigma)$ ln $(vx_0/\sqrt{1-\beta^2}\ \Omega)$. (TTT)

33730 MEASURING THE MASS OF CHARGED PARTICLES BY MEANS OF SCINTILLATION COUNTERS. A. V. Karimyan, K. Sh. Egiyan, N. A. Nalbandyan, V. V. Avakyan, and V. A. Karapetyan (Physics Inst., Armenian Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 831-6(June 1962). (In Russian)

The mass of a particle can be determined by measuring its energy and range, if the particle is stopped solely as a result of ionization losses. The magnitude of the energy loss of a particle having an ionizing ability of I/I_{min} in a scintillator C is equal to $\Delta E = B\ (I/I_{min})_C\ l$, where B is the minimum ionization loss in the scintillator in bev cm^{-1}, and l is the thickness of the scintillator in cm. The experimental unit consisted of a magnetic mass-spectrometer ($\overline{H} = 6850$ Oe), a five-layered proportional counter, and five scintillation counters. The average error in determining a momentum of 0.2 and 1 Bev/c was 5 to 8% for protons, and 2 to 4% for π-mesons. The ionizing ability of the particle was determined on the proportional counter with an average accuracy of ±14%. The energy loss of a particle stopped in a scintillator was determined with an average energy of ±10%. The value of I_{min} was determined for each 3 scintillators for μ-mesons having a momentum of 300 to 430 Mev/c, and for various proton energies. The mass of the particle was also determined from the momentum and ionizing ability of the particle in the gaseous proportional counter. The average error in determining the mass of the proton by stopping it in the scintillator was ±17%. The results show that the mass of a particle can be determined by measuring energy and range of the particle which is stopped within three or more scintillators. The behavior of unstable particles in a scintillator was not clarified. (TTT)

33731 MEASURING THE MASSES OF LOW-INTENSITY GROUPS OF CHARGED PARTICLES BY VARIOUS METHODS. A. V. Khrimyan, K. Sh. Egiyan, N. A. Nalbandyan, V. V. Avakyan, and V. A. Karapetyan (Physics Inst., Academy of Sciences, Armenian SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 837-40(June 1962). (In Russian)

A mass-spectrometer ($\overline{H} = 6850$ Oe) was used to determine the momentum of a particle from 0.2 to 1 Bev/c. The ionizing ability of the particle was determined on a five-layered, thin-wall proportional counter with an accuracy of ±14%, and the range and energy of the particle could be determined by stopping it in a unit of five scintillation counters. Thus, the mass of the particle can be determined by six different methods on the basis of four independent determinations of the momentum, ionizing ability (by means of the gaseous counter), and the range and energy (by means of the scintillation counters). The mass spectrum obtained by the momentum-ionization method is the most reliable, since this method is not sensitive to non-ionization losses of particle energy. The momentum-energy method, and the ionization-energy method give higher masses for protons and deuterons. The ionization-energy method, the ionization-range method, and the energy-range method give lower masses for protons and deuterons. The non-ionization losses in particle energy must be taken into account in order to obtain reliable mass values. (TTT)

33732 THE SCATTERING OF A NEUTRON BY A NEUTRON. G. E. Velyukhov and A. N. Prokof'ev (Ioffe Inst. of Technical Physics, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 1113-15(Aug. 1962). (In Russian)

The energy for the interaction of two nucleons ϵ, the scattering length a, and the sign of the energy are important characteristics for the interactions of nucleons in the singlet state. Since these characteristics cannot be determined for neutrons by direct experiment, it was proposed that the reaction $d + n \rightarrow p + 2n$ be used. Here, the final states contain two interacting neutrons in the singlet state with a low energy with respect to the center-of-gravity. With incident 14.1-Mev neutrons, the final maximum energy of the protons would be 11.8-Mev, if the binding energy of the deuteron is taken as 2.225 Mev, and if the binding energy of the two neutrons is set equal to zero. Fast monochromatic neutrons were obtained from the $T + d \rightarrow \alpha + n$ reaction. Neutrons emitted at an angle of 90° with respect to the direction of motion of the primary deuterons were selected. The target having a density of 10 mg/cm^2 was made of deuterated polyethylene on a tantalum backing. The telescope consisted of two proportional counters and a scintillation spectrometer. The deuterons were discriminated from the protons by electronic means, and the energy distribution of the protons was obtained at the same time. The study was carried out at an angle of 0° with respect to the direction of motion of the primary neutrons. A maximum in the proton spectrum was found at 11.7 ± 0.2 Mev. A hydrogen impurity of ~5% gave a maximum at 14.1 Mev which served as a convenient reference point in calibrating the spectrometer. No definite conclusion on the interaction energy of the two neutrons in the singlet state could be drawn because of the high corrections for the ionization losses by the proton in the target and other parts of the telescope. (TTT)

33733 ON THE SMALL SIGNAL POWER THEOREM OF ELECTRON BEAMS. D. L. Bobroff (Raytheon Co., Waltham, Mass.), H. A. Haus, and J. W. Kluever. J. Appl. Phys., 33: 2932-42(Oct. 1962).

The small-signal-power theorem for electron beams is reviewed. The physical significance of the theorem is explained and its role as a mathematical identity is discussed. The assumptions and boundary conditions of the linearized theory are stated. The theorem is derived in a simplified way. Examples and applications are treated. (auth)

33734 POTENTIAL FORM OF THE SMALL SIGNAL POWER THEOREM. J. W. Kluever (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 33: 2943-7 (Oct. 1962).

The small signal power theorem for electron beams is transformed into a form that lends itself to practical applications. This transformation is achieved by the introduction of scalar and vector potentials. The theorem is also presented in four-vector notation. As an example of the application of the theorem, the one-dimensional excitation of a cylindrical beam is discussed. (auth)

33735 THE THEORY OF ČERENKOV EFFECT BASED ON LORENTZ TRANSFORMATIONS. Leon W. Zelby (Radio Corp. of America, Camden, N. J.). J. Appl. Phys., 33: 2995-8(Oct. 1962).

The method of calculating r-f excitation by the Cherenkov effect using Lorentz transformations was extended to a modulated electron beam in the presence of a finite dielectric boundary. A relation between the Cherenkov effect and Roentgen surface current was pointed out. (auth)

33736 THE PRINCIPLE OF STATE LEVELLING AND CALCULATIONS OF MULTIPLE PRODUCTION. G. I. Kopylov (Joint Inst. of Nuclear Research, Dubna, USSR). Nucl. Phys., 37: 425-37(Sept. 1962). (In English)

In evaluating multidimensional integrals it is useful to make substitutions of variables in order to reduce the variation of the integrands. This principle underlies the approximate calculation of statistical weights. As applied to covariant phase volumes the method yields formulae suited to numerical computations. It is shown with the help of these formulae that the covariant model of multiple meson production is not inferior to the Fermi model in reproducing the average multiplicity of the produced mesons. It is also shown that the same substitutions reduce by several orders the time needed for calculating the Fermi model by the Monte Carlo method. (auth)

33737 THREE-PARTICLE ASSOCIATED PRODUCTION IN PION-NUCLEON COLLISIONS. K. Raman (Inst. of Mathematical Sciences, Madras). Nucl. Phys., 37: 438-48 (Sept. 1962). (In English)

The production of $Y\bar{K}\pi$ and $NK\bar{K}$ in pion-nucleon collisions is studied in the single-particle-exchange model. The total cross sections for the reactions and the angular distributions and energy spectra of the recoil hyperons are calculated. The reactions are compared with each other and with the $N\pi\pi$ production reaction. There is a significant difference between the $\Sigma K\pi$ and the $\Lambda K\pi$ reactions if the $\Sigma\Lambda$ parity is odd. (auth)

33738 THE INTERPOLATION PROBLEM IN THE THEORY OF COMPLEX ANGULAR MOMENTUM. T. Regge (Università, Turin) and G. A. Viano. Nuovo cimento (10), 25: 709-22(Aug. 16, 1962). (In English)

An analytic function of a complex variable z is considered that is regular in the half-plane Re (z) > 0. A method for reconstructing the function from the knowledge of its values on a set of equally spaced points on the real axis of z is shown. In order to insure uniqueness of the solution additional asymptotic properties of the function are requested. A proposal is made to apply the procedure to a number of physical problems where analytic properties are derived from dispersion-theoretical arguments. (auth)

33739 ON THE SPIN AND PARITY OF THE Y*-RESONANCE. Alladi Ramakhrishnan, T. K. Radha, R. Thunga, and A. P. Balachandran (Inst. of Mathematical Sciences, Madras). Nuovo cimento (10), 25: 723-9(Aug. 16, 1962). (In English)

Using the static model and the effective range approximation, the possibility of a $\Lambda\pi$ resonance with $J = 3/2$ or $5/2$ in different orbital momentum states is investigated. In particular, if the resonance has $J = 3/2$ and $l = 2$, it is found that the observed width may be reproduced if the $\Sigma\Lambda$ parity is odd with the $\Sigma\Lambda\pi$ coupling constant $g^2_{\Sigma\Lambda\pi}/4\pi \approx 20$. If, however, the $\Sigma\Lambda$ parity is even, $g^2_{\Sigma\Lambda\pi}/4\pi$ comes out to be of the order of 100. (auth)

33740 DIFFRACTION SCATTERING AND MANDELSTAM REPRESENTATION. C. Lovelace (Imperial Coll. of Science and Tech., London). Nuovo cimento (10), 25: 730-55(Aug. 16, 1962). (In English)

The Mandelstam representation is applied to π-p elastic scattering in the Bev region. The double spectral function is calculated from the observed angular distribution at 5 Bev/c by a conformal mapping extrapolation technique. The result is a strongly oscillating function of the type considered by Regge in potential scattering. From the analogy with Regge, a formula is derived for the double spectral function that explains all the π^--p experiments above 3 Bev/c, and fits the forward peak down to 1.3 Bev/c. The formula gives better agreement with experiment than the optical model for wide angle scattering. The formula also predicts a slow

energy dependence of the optical model parameters. A construction for obtaining Regge poles from physical phase shifts, and vice versa is given. This construction indicates a pion-pion resonance in the I = 0, D-wave state. (auth)

33741 RADIATION FROM A CHARGED PARTICLE IN UNIFORM STRAIGHT MOTION THROUGH A PARTICULAR STRATIFIED MEDIUM. R. Pratesi (Università, Florence), G. Toraldo di Francia, L. Ronchi, and A. M. Scheggi. Nuovo cimento (10), 25: 756-77(Aug. 16, 1962). (In English)

The stratified medium considered is constituted by a set of N equispaced metallic films imbedded in a homogeneous isotropic dielectric. The films are assumed to be infinitely thin and to have a reflection coefficient $\rho_0 < 1$. A general expression of the radiated electromagnetic field is found for particle velocities below the Cherenkov threshold for the dielectric considered. Numerical evaluations are performed in the particular cases N = 1, N = 2, N = ∞; the results show that the gain over the case of a single film with infinite conductivity presents rather steep peaks, revealing the existence of sharp cones of radiation. It seems that the structure may be employed for measuring the particle velocity as well as for generating millimetric and submillimetric power. (auth)

33742 SOME REMARKS ABOUT UNITARITY. R. Omnès (Institut des Hautes Etudes Scientifiques, Paris). Nuovo cimento (10), 25: 806-16(Aug. 16, 1962). (In English)

After some considerations on the mathematical expression of unitarity relations in a scattering process, particularly for amplitudes verifying a fixed-energy dispersion relation, the integral properties of the kernel of unitarity when applied to Legendre functions of complex order are studied. As an application, a holomorphy domain is determined for a scattering matrix element as a function of a complex angular momentum. The occurrence of Regge poles in every channel of a many-channel process is proved. (auth)

33743 ELECTROMAGNETIC FORM FACTORS IN THE REGGE REPRESENTATION. M. McMillan and E. Predazzi (Università, Turin and Istituto Nazionale di Fisica Nucleare, Turin). Nuovo cimento (10), 25: 838-45(Aug. 16, 1962). (In English)

The electromagnetic form factors of the nucleon are discussed on the basis of the Regge theory of potential scattering. A connection between the form factors and the Regge trajectories is found, thus allowing general conclusions about the form factors to be made. A comparison with experiments is given. (auth)

33744 THE $K^+ \rightarrow \pi^+ + e^+ + e^-$ DECAY. M. Baker and S. L. Glashow (Stanford Univ., Calif.). Nuovo cimento (10), 25: 857-63(Aug. 16, 1962). (In English)

The rate of $K^+ \rightarrow \pi^+ + e^+ + e^-$ decay is examined, and is found to depend strongly upon the pion electromagnetic form factor. The branching ratio is estimated to be about 10^{-6}. (auth)

33745 A THEORY OF HYPERFRAGMENTS. III. $\Lambda\Lambda - \Lambda\Sigma$ EXCHANGE FORCES AND π^+-MESIC DECAY. S. Iwao (Syracuse Univ., N. Y.). Nuovo cimento (10), 25: 890-900(Aug. 16, 1962). (In English)

A determination of the nucleon−Λ interaction parameters is carried out by making use of experimental information on the Λ binding energies for p-shell hyperfragments. The parameters thus obtained favor an anti-parallel spin for p-shell hyperfragments. The study of the exchange forces gives information on the probability of the Σ^+-bound state. The probability amplitude obtained in this way is compared with the observed probability of hyperfragment decay by π^+ emission. (auth)

33746 ANALYTICITY AND UNITARITY. [PART] II. J. C. Polkinghorne (Inst. for Advanced Study, Princeton, N. J.). Nuovo cimento (10), 25: 901-11(Aug. 16, 1962). (In English)

The singularities of unitary theories are discussed. A derivation of Cutkosky's formula for the discontinuity of first-type Landau singularities is given, without recourse to perturbation theory. The discontinuities associated with second-type singularities are discussed. The form of these discontinuities is completely determined once the pure second-type discontinuity is known. (auth)

33747 EFFECT OF HIGH-ENERGY LIMITS ON THE NUCLEON FORM FACTORS. K. C. Wali (Johns Hopkins Univ., Baltimore). Nuovo cimento (10), 25: 912-22(Aug. 16, 1962). (In English)

The consequences of using certain high-energy conditions on the dispersion-theoretic fit to the electromagnetic form factors of the nucleon are examined. It is shown that as a consequence of these conditions and the usual conditions that define the charge and the anomalous magnetic moments, at least four pion-pion resonances with spin and parity 1^-, two of which are iso-vector and two of which are iso-scalar, must exist. If the masses of these resonances are known, the Pauli form factors of both the proton and the neutron may be determined in terms of these masses. There are only two free parameters for fitting the Dirac form factors. Numerical results are discussed in terms of pion-pion resonances. (auth)

33748 SEARCH FOR A FOUR-PION RESONANCE, AND SOME DECAY MODES OF THE ρ AND ω-MESONS. Nguyen-Huu Xuong and G. R. Lynch (Univ. of California, Berkeley). Nuovo cimento (10), 25: 923-30(Aug. 16, 1962). (UCRL-10089). (In English)

A search for four-pion resonances among six-prong annihilations of 1.61-Bev/c antiprotons in a hydrogen bubble chamber is made. No four-body decays of the ρ or ω mesons are observed, and upper limits for these decays are quoted. The fraction of the charged ρ mesons that decay via $\rho^\pm \rightarrow \eta + \pi^\pm$ is determined to be $(1.2 \pm 2)\%$, in agreement with a positive G parity assignment for the η. The neutral four-pion effective mass distribution shows a suggestive, but inconclusive, peak at 1.04 Bev. (auth)

33749 PHOTOPRODUCTION OF PIONS ON Λ-HYPERONS. Alladi Ramakrishnan, T. K. Radha, R. Thunga, and A. P. Balachandran (Inst. of Mathematical Sciences, Madras). Nuovo cimento (10), 25: 939-41(Aug. 16, 1962). (In English)

The process $\gamma + \Lambda \rightarrow \Lambda + \pi$ is discussed, assuming the Λ-π interaction proceeds mainly through S waves. The treatment is carried out for both even and odd relative ΣΛ parity. (T.F.H.)

33750 THE LOW-ENERGY TWO-PION PROBLEM. J. G. Taylor (Inst. for Advanced Study, Princeton, N. J.) and T. N. Truong. Nuovo cimento (10), 25: 946-51(Aug. 16, 1962). (In English)

The inverse-amplitude method is used to study pion-pion interactions. Only S- and P-wave absorption are considered; all other partial waves are set equal to zero. The S and P waves are assumed to have the properties of analyticity, unitarity on the right-hand cut, and crossing symmetry. An attempt is made to minimize the number of parameters involved in the analysis. A possible approximate set of low-energy solutions for the S- and P-wave shifts is presented. (T.F.H.)

33751 MAGNITUDE OF THE $\Delta I = 3/2$ AMPLITUDE IN $K^+_{\pi 3}$ DECAY. H. Chew (Univ. of Pennsylvania, Philadelphia). Nuovo cimento (10), 25: 952-5(Aug. 16, 1962). (In English)

It is shown that under certain assumptions the ($\Delta I = 3/2$ amplitude)/($\Delta I = 1/2$ amplitude) ratio in $K^+_{\pi 3}$ decay may be estimated from the $K^+_{\mu 3}/K^+_{e3}$ branching ratio and the μ meson spectrum in $K^+_{\mu 3}$ decay. The K^+_{e3} decay is assumed to be a V - A interaction, and a weakened form of the partially-conserved-current hypothesis is postulated. The implications of the results with respect to resonant states in the K-π interaction are outlined. (T.F.H.)

33752 ON THE INTERACTIONS OF π^--MESONS WITH NUCLEONS AND NUCLEI. I. Ciulli, V. V. Glagolev, V. A. Nikitin, V. Petržílka, V. A. Sviridov, and K. D. Tolstov (Joint Inst. for Nuclear Research, Dubna, USSR). Nuovo Cimento (10), 25: 1197-1204(Sept. 16, 1962). (In English)

The inaccuracy of several analytic methods for interactions of nucleons and pions with nucleons or nuclei at energies up to 10 Bev is discussed. Using experimental data on π^+-nucleon and π^--nucleus collisions at 7 Bev/c, it is shown that the shower mechanism in the interactions with nuclei is compatible with experimental results. Finally, it is shown that on the basis of experimental results it is not possible to distinguish, in the interactions of pions with nuclei, collisions with targets of different masses ($\pi, 2\pi, \ldots, 24$), using a particular method. (auth)

33753 ON THE ROLE OF GRAVITATIONAL FIELDS IN SOME ELEMENTARY PARTICLE PROCESSES. L. Halpern (Univ. of North Carolina, Chapel Hill). Nuovo Cimento (10), 25: 1239-69(Sept. 16, 1962). (In English)

With the aid of a suitable perturbation formalism, the effect of an external gravitational field on elementary particle processes is investigated. Electromagnetic bremsstrahlung emission by charged-scalar-particle waves is treated, and the dependence of the result on the inserted data and their empirical limits is analyzed. Application of the results to gravitational bremsstrahlung by particles of vanishing rest-mass is made. On the basis of these results, gravitational radiation from elementary-particle processes is shown to be negligible. Some quantum-electrodynamic processes of higher order that have closed loop diagrams are treated in curved space, and the removal of their infinities by renormalization is discussed. Part of the matrix element for the process of photon trisection into three photons is evaluated, and an upper limit for the cross section of this process is obtained in first-order approximation in the external gravitational field. The magnitude of certain contributions from higher order terms is estimated. A number of other processes, involving particles with spin and their radiative corrections, are treated or discussed. Among the cross sections of these processes, in first-order perturbation only that for the trisection of photons becomes significant at the empirical energy limit: these theoretical results deny experimental verification. Empirical aspects of the theoretical results are discussed. An auxiliary theorem is given on a relation between the second derivatives of the metric tensor and the Riemann-Christoffel tensor at particular points, using geodesic co-ordinates. (auth)

33754 ELECTROMAGNETIC MIXING EFFECTS IN ELEMENTARY-PARTICLE PHYSICS. J. Bernstein (Brookhaven National Lab., Upton, N. Y.) and G. Feinberg. Nuovo Cimento (10), 25: 1343-55(Sept. 16, 1962. (BNL-6122). (In English)

A study is made of the electromagnetic mixing of particle pairs having similar quantum numbers except for their isotopic spins. The derived formulae are applied to the ρ,ω pair, for which there is evidence that such effects exist and are important. (auth)

33755 ANALYTIC PROPERTIES OF KAON-PION SCATTERING AMPLITUDE. Y. S. Jin (CERN, Geneva). Nuovo Cimento (10), 25: 1356-68(Sept. 16, 1962). (In English)

Some rigorous analytic properties of the kaon-pion scattering amplitude as a function of energy and momentum transfer are proved. The partial wave amplitudes turn out to be analytic in the neighborhood of the elastic cut, and analytic continuation into the second Riemann sheet may be carried out. (auth)

33756 ON THE INTERPRETATION OF THE τ-FUNCTIONS IN HEISENBERG'S NONLINEAR THEORY OF ELEMENTARY PARTICLES. E. Montaldi (Università, Milan and Istituto Nazionale di Fisica Nucleare, Milan). Nuovo Cimento (10), 25: 1369-74(Sept. 16, 1962). (In English)

Some particular cases of a general formula in Heisenberg's nonlinear spinor theory are studied. (auth)

33757 A CLASSIFICATION OF RESONANCES. R. Omnes (Institut des Hautes Etudes Scientifiques, Paris). Phys. Letters, 1: 149-50(June 1, 1962).

Angular momentum, parity, strangeness, isotopic spin, and baryon number are designated as "known quantum numbers," and on this basis, a set of rules is proposed for classifying resonances. The classification comprises two broad groups, one of which includes bound states and narrow resonances, and the other broad resonances. Further properties of the members of these groups are delineated. The theoretical and phenomenological implications of this classification scheme are outlined. (T.F.H.)

33758 CHOICE OF ELECTROMAGNETIC FORM FACTORS. K. J. Barnes (Imperial Coll. of Science and Tech., London). Phys. Letters, 1: 166-8(June 1, 1962).

Alternate choices of form factors for neutrons and protons are discussed. The expression of the charge (F_c) and magnetic moment (F_m) form factors in terms of Pauli and Dirac form factors is outlined. Conjectures are presented regarding the values of the form factors, viz. $F_c^p = F_m^p$, $F_c^n = 0$, $F_c^s = F_c^v = F_c^p$, and possibly $F_m^n = F_m^p$ and $F_m^v = F_m^s = F_m^p$. Superscripts "s" and "v" refer to "scalar" and "vector" respectively. (T.F.H.)

33759 STRIPPING CROSS SECTIONS FOR 620 Mev DEUTERONS. K. R. Chapman, G. Martelli, H. B. Van der Raay, D. H. Reading, and R. Rubinstein (Univ. of Birmingham, Eng.). Phys. Letters, 1: 168-70(June 1, 1962).

The angular distributions and cross sections for (d,p) reactions on C and Cu at 620 Mev are measured, and the cross section values are used to calculate the nuclear radii of C and Cu. (T.F.H.)

33760 AN EXAMPLE OF AN N^{14} HYPERFRAGMENT. D. J. Prowse (Univ. of California, Los Angeles and Lockheed California Co., Los Angeles). Phys. Letters, 1: 178-80 (June 1, 1962).

An event is described in which a K^- meson comes to rest and reacts with an emulsion nucleus. From this interaction are emitted a π meson and a short-range (2.0 ± 0.5 μ) hyperfragment. The hyperfragment decays by π^- emission. It is concluded that the hyperfragment is most likely ${}_\Lambda N^{14}$, with a Λ binding energy of 11.7 ± 7 Mev. Other possible identities of the hyperfragment are discussed. (T.F.H.)

33761 THE SEARCH FOR HIGH ISOSPIN STATES OF ELEMENTARY PARTICLES. Albert Messiah (Centre d'Etudes Nucléaires, Saclay, France). Phys. Letters, 1: 181-4(June 1, 1962).

A discussion is presented of theoretical models and experimental verification of high-isospin states of elementary particles. Particular attention is given to isospin (I) = $5/2$

and $^7/_2$ states of nucleons, I = 2 states of hyperons, and I = $^3/_2$ states of K mesons. (T.F.H.)

33762 NEUTRAL MESON PHOTOPRODUCTION FROM COMPLEX NUCLEI. R. A. Schrack (National Bureau of Standards, Washington, D. C.), J. E. Leiss, and S. Penner. Phys. Rev., 127: 1772-83(Sept. 1, 1962).

The angular distributions of neutral mesons produced by 170-Mev bremsstrahlung on carbon, aluminum, copper, cadmium, and lead are obtained through the coincident detection of the decay photons by a scintillation counter system. The experimental data are analyzed by means of a Monte Carlo prediction based on an impulse-approximation elastic coherent production model. The nuclear density distributions used in the synthesis of those predictions that are in best agreement with the data from this experiment are compared to the charge density distributions inferred from electron scattering experiments. The values of the rms radii of nuclear matter obtained in this experiment are, within the limits of error of the experiment (about 2×10^{-14} cm), consistent with the values of charge distribution radii obtained in electron scattering. The spin-independent part of the neutral meson photoproduction cross section used in the synthesized predictions is obtained using dispersion theory. The dependence of the cross section on the meson-nucleon phase shifts used is investigated, and a set of phase shifts is presented that results in a correct prediction of the absolute cross sections observed in this experiment; however, this set of phase shifts is not unique. (auth)

33763 LOW-ENERGY LIMIT OF THE PHOTODISINTEGRATION OF THE DEUTERON. Bunji Sakita (Univ. of Wisconsin, Madison). Phys. Rev., 127: 1800-6(Sept. 1, 1962).

The exact transition amplitude for the photodisintegration of the deuteron at the zero-energy limit of the incident γ ray is presented as a function of the electric charges and the magnetic moments of the proton, neutron, and deuteron, the effective range for triplet n-p scattering, and the binding energy of the deuteron. The method used is based on the theory of composite particles in quantum theory. The low-energy limit presented results from the application of a generalization of a theorem of pion photoproduction, including a composite particle. (auth)

33764 G PARITY AND THE INTERACTIONS OF HEAVY MESONS. D. B. Lichtenberg and G. C. Summerfield (Michigan State Univ., East Lansing). Phys. Rev., 127: 1806-8(Sept. 1, 1962).

Some implications of the G parity of heavy mesons are discussed. It is pointed out that the G parity of a meson may determine whether a meson can contribute to a pole term in the nucleon-nucleon scattering amplitude. Since G parity may not be conserved in the decays of some heavy mesons, G must be determined indirectly. One method is to measure the charge parity of the decay products of a neutral meson, a quantity which determines G if the isospin of the meson is known. Selection rules for the decay of neutral and charged mesons are given. Results are applied to the ζ and η mesons. (auth)

33765 SUGGESTED QUANTUM NUMBERS FOR BOSONS OF MASS $\approx 4m_\pi$. E. M. Henley and B. A. Jacobsohn (Univ. of Washington, Seattle). Phys. Rev., 127: 1829-31(Sept. 1, 1962).

The decay modes of the ζ(T = 1) and η(T = 0) bosons of mass $\approx 4m_\pi$ are discussed, together with other experiments bearing on quantum number assignments for these mesons. Using an effective interaction that includes the influence of angular momentum barriers, numerical estimates are made of branching ratios. Arguments based on these estimates lead to the most likely spin and parity assignments of $J^{PG} = 0^{+-}$ for ζ and 0^{--} for η. Study of the reaction π + He → ζ + He is proposed as a test of the 0^+ assignment. (auth)

33766 TRIDENT PRODUCTION CROSS SECTION AND QUANTUM ELECTRODYNAMICS AT SMALL DISTANCES. Mao-Chao Chen (Stanford Univ., Calif.). Phys. Rev., 127: 1844-6(Sept. 1, 1962).

The cross section is calculated for electron-positron pair production from electron-proton collisions, as a test of quantum electrodynamics at small distances. The electrons and positrons are considered highly relativistic and the protons are considered as Coulomb field sources; otherwise the calculations are exact to the fourth order of the matrix element. Distances probed are about 0.5 fermi. (auth)

33767 WAVE DISTORTION FOR MAGNETIC MOMENT EFFECTS IN NUCLEON-NUCLEON SCATTERING. G. Breit and H. M. Ruppel (Yale Univ., New Haven, Conn.). Phys. Rev., 127: 2123-33(Sept. 15, 1962). (TID-15809)

Difficulties encountered in making corrections for the effects of nucleonic magnetic moments on nucleon-nucleon scattering, on account of the unknown effects of wave function distortion, are studied. A partial removal of the difficulty is accomplished by correcting for the magnetic moment effect only in the one-pion exchange (OPE) group of phase parameters. Wave-function distortion in that group is relatively small and the error committed is less serious than if the magnetic effects are used for the whole wave. Since the low L group has its phase parameters determined by adjustment to data, these parameters have to be interpreted as including the magnetic moment effects, which will eventually have to be corrected for, when the origin of the nucleon-nucleon phase shifts is understood quantitatively in other respects. Formulas for the calculation of the magnetic moment effects in the high L group are supplied and some typical cases are considered numerically. Relatively large effects are found for the polarization and the triple-scattering parameter at very small angles. The complication arising in n-p data analysis from coupling of states with different isotopic spin is pointed out. (auth)

33768 DEPOLARIZATION PARAMETER IN PROTON-PROTON SCATTERING AT 213 Mev. Kazuo Gotow, Frederick Lobkowicz, and Ernst Heer (Univ. of Rochester, N. Y.). Phys. Rev., 127: 2206-16(Sept. 15, 1962). (NYO-10135)

The depolarization parameter (D) in p-p scattering at 213 Mev is measured over the cms angular range 30 to 90°. The results may be used to yield a unique phase-shift set for p-p interaction at this energy. The results of the experiment are also compared with the predictions by semi-phenomenological potentials. (auth)

33769 MEASUREMENT OF THE MAGNETIC MOMENT OF THE Λ^0 HYPERON. R. L. Cool (Brookhaven National Lab., Upton, N. Y.), E. W. Jenkins, T. F. Kycia, D. A. Hill, L. Marshall, and R. A. Schluter. Phys. Rev., 127: 2223-30 (Sept. 15, 1962). (BNL-6121)

A measurement of the magnetic moment of the Λ^0 hyperon gives the value $\mu_{\Lambda^0} = -1.5 \pm 0.5$ nuclear magnetons. Polarized Λ^0 hyperons are produced by 1.02 ± 0.03 Bev/c π^+ mesons incident on a Be target in the reaction $\pi^+ + n \rightarrow \Lambda^0 + K^+$. After passing through a strong magnetic field, the Λ^0 are observed to decay in a parallel plate spark chamber triggered by an electronic counter logic. The asymmetry of the π^- from the decay $\Lambda^0 \rightarrow \pi^- + p$ provides the method for determining the axis of polarization. The magnetic field and flight path are such that a magnetic moment of one nuclear

magneton would precess 16.5° in a plane perpendicular to the A^0 trajectory. Measurement of the angle of rotation of the decay pattern with field on, off, and reversed give the magnitude of the moment; the sense of rotation yields the sign. (auth)

33770 CHARGE STRUCTURE OF THE NUCLEON. K. Hlida (Argonne National Lab., Ill.). Phys. Rev., 127: 2231-5(Sept. 15, 1962). (TID-15838)

It is suggested that F_{1n}, the charge form factor of the neutron, is negative at low transferred momentum, and that the charge distribution of the proton is such that the bare proton is surrounded not only by a positively charged layer but also by a negatively charged layer because of the strong vacuum polarization resulting from the three-pion resonance ω. (auth)

33771 TWO-PARTICLE APPROXIMATION FOR THE THREE-PION AMPLITUDE. David R. Harrington (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 127: 2235-40(Sept. 15, 1962).

A two-particle approximation is suggested for the $3\pi \to 3\pi$ amplitude, as follows: the amplitude is replaced by a $\rho + \pi \to \rho + \pi$ amplitude multiplied by 2π resonance factors. An approximate calculation of the J = 1−, T = 0 partial wave for the ρ-π amplitude is made, including only the "elastic" and one-pion-exchange cuts, but it seems to give no hint of a 3π resonance. (auth)

33772 INFLUENCE OF $\bar{K}$-NUCLEON INTERACTIONS ON PION-HYPERON SCATTERING. T. Laurence Trueman (Univ. of Chicago). Phys. Rev., 127: 2240-56(Sept. 15, 1962). (EFINS-62-19)

Scattering amplitudes for coupled $\pi\Lambda$, $\pi\Sigma$, and $\bar{K}N$ channels are obtained. The method is shown to be essentially equivalent to the N/D method in the region of nonrelativistic baryon energies, under the assumption that the only important forces arise from the Born singularities. All possibilities for the $\Sigma\Lambda$ and $\bar{K}\Lambda$ relative parities are considered. The aim is to see to what extent calculations neglecting the $\bar{K}$-N interactions are modified by its inclusion. If the $\bar{K}N$ coupling constants are as strong as the πN coupling, significant quantitative and qualitative modifications are obtained: an I = 1, J = ½ resonance with the properties of the Y_1^* may be obtained for $P(\Sigma\Lambda) = \pm 1$; an I = 0 resonance with the location and width of the Y_0^* may be obtained for $P(\Sigma\Lambda) = -1$, in the $P_{3/2}$ state, and for $P(\Sigma\Lambda) = +1$, in the $P_{1/2}$ state. If the $\bar{K}N$ couplings are significantly weaker than the πN coupling, a $P_{3/2}$ resonance with the properties of the Y_1^* is obtained only if $P(\Sigma\Lambda) = +1$ and if the $\Sigma\Sigma\pi$ coupling is very weak; in this case no I = 0 resonance identifiable with the Y_0^* is found. An I = 0, $P_{3/2}$ resonance at 1520 Mev may be obtained with a wide variety of couplings for $P(\Sigma\Lambda) = +1$; the predicted width of this resonance is very large ($\Gamma/2 >$ 50 Mev). Resonances in other states, multichannel effects on resonance shapes, and KN elastic scattering are discussed. (auth)

33773 ANALYTICITY OF THE POSITIONS AND RESIDUES OF REGGE POLES. John R. Taylor (Univ. of California, Berkeley). Phys. Rev., 127: 2257-60(Sept. 15, 1962).

The amplitude a(l,k) for scattering by a superposition of Yukawa potentials is considered as a meromorphic function of angular momentum l and linear momentum k. An N/D representation is explicitly given, and is then used to show that the position, $\alpha(k)$, and the residue, $\beta(k)$, of its poles in l—the so-called Regge poles—are holomorphic functions of k, under a certain assumption. Further considered as functions of energy, α and $\beta/k^{2\alpha}$ are shown to be real-analytic with no left-hand cut. (auth)

33774 COMPLEX ANGULAR MOMENTUM IN TWO-CHANNEL PROBLEMS. A. M. Jaffe and Y. S. Kim (Princeton Univ., N. J.). Phys. Rev., 127: 2261-66(Sept. 15, 1962).

Analytic properties of the two-channel S matrix are investigated, and the threshold behavior of each channel is also studied. It is concluded that a certain class of potentials leads to an S matrix that has branch points in linear momentum space and is an entire meromorphic function in the complex angular momentum plane. A formula is given that displays the discontinuity across the threshold cut as an explicit function of the angular momentum. (auth)

33775 REGGE POLES AND HIGH-ENERGY LIMITS IN FIELD THEORY. B. W. Lee (Inst. for Advanced Study, Princeton, N. J. and Univ. of Pennsylvania, Philadelphia) and R. F. Sawyer. Phys. Rev., 127: 2266-73(Sept. 15, 1962).

It is shown that the Bethe-Salpeter scattering amplitude in the ladder approximation is meromorphic in the complex angular momentum half-plane, $\mathrm{Re}\, l > -\frac{1}{2}$. There is always at least one Regge pole in this region. The T matrix element for complex l can be written in the form $N_l D_l^{-1}$, where N_l and D_l have convergent perturbation expansions. D_l has only a right-hand cut in the squared energy variable, with a branch point at the elastic scattering threshold and at each production threshold. N_l has a left-hand cut, and in addition a right-hand cut beginning from the first three-particle threshold. The Regge poles are zeros of D_l. Much of the information about the trajectories of Regge poles is contained in the lowest-order expression for D_l. The general properties of the trajectories are the same as for the case of scattering from a Yukawa potential. For sufficiently small coupling constant a Regge trajectory $\alpha(s)$ may apparently be expanded in a perturbation series, valid except near thresholds in s. The connection between the Regge poles of the ladder graphs and the high-energy behavior of the "strip" graphs is discussed. It is shown that the second-order expression for the leading Regge trajectory, for the sum of the ladder graphs, determines the leading term in the high-energy limit of the nth order strip graph. This relationship is checked in fourth-order perturbation theory, and is evidence for the consistency of a perturbation approach to the calculation of Regge trajectories. (auth)

33776 LEADING REGGE TRAJECTORY IN THE $\lambda\varphi^4$ THEORY. B. W. Lee (Inst. for Advanced Study, Princeton, N. J., and Univ. of Pennsylvania, Philadelphia) and R. F. Sawyer. Phys. Rev., 127: 2274-6(Sept. 15, 1962).

In a field-theoretic model of pion-pion scattering, it is shown that the leading Regge pole approaches l = 0 as the squared energy approaches $\pm\infty$. (auth)

33777 CONCERNING THE NOTION OF "TIME INTERVAL" IN S-MATRIX THEORY. Marvin L. Goldberger (Princeton Univ., N. J.) and Kenneth M. Watson. Phys. Rev., 127: 2284-6(Sept. 15, 1962). (UCRL-10155)

The notion of time duration is considered within the framework of S-matrix theory. It is shown that definition of the time delay as $-i\hbar[(d \ln S/dE)]$, for a scattering process, permits a definition of time duration in a "coarse-grained" sense. (auth)

33778 POLARIZATION OF ELECTRONS BY ATOMIC BEAMS. Hugo Friedmann. Sitzber. Math.-Naturw. Kl. Bayer. Akad. Wiss. Muenchen, 1961, 13-47(1962). (In German)

As an introduction beam polarization is defined, and methods for the polarization of an electron beam are given. The principle of electron polarization by atomic beams is reviewed, and the construction of an apparatus for electron polarization is described. The methods used for the meas-

urement of the intensity of polarized electrons and the degree of polarization are discussed. The production of highly accelerated electrons is then considered. (J.S.R.)

Neutron Physics

33779 (AEEW-M-269) THE USE OF THE $S^{32}(n,p)P^{32}$ REACTION FOR THE MEASUREMENT OF FAST NEUTRON FLUX IN REGIONS OF LOW INTENSITY. A. K. McCracken, R. Jowitt, and M. Lock (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). June 1962. 14p.

The use of the $S^{32}(n,p)P^{32}$ reaction was extended, by the burning technique, to measurements of fast neutron flux in the region 0.1 to 1.0 $n/cm^2/sec$. (auth)

33780 (AEEW-R-70) THE TRANSMISSION OF THERMAL NEUTRONS ALONG AIR FILLED DUCTS IN WATER. D. C. Piercey (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). June 1962. 35p.

Predictions and measurements of thermal neutron transmission along air filled ducts in water were made. To aid the analysis, the ducts were shielded in various ways using Cd sheet. The predictions were, in general, in agreement to better than a factor 4 for ducts up to 200 duct radii in length. (auth)

33781 (AEEW-R-116) THE NEUTRON CROSS-SECTIONS OF Xe135. H. M. Sumner (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). June 1962. 14p.

Measurements of the total and absorption cross-sections of Xe^{135} are reviewed. The low-energy cross-section is very large and dominated by a single resonance at 0.084 ev; the spin state for this level is not known, this being one of the major uncertainties in the data. The resonance parameters given in the literature were found to give a good fit to the total cross-section but failed to reproduce the preferred 2200 m/sec value of σ_γ. A new set of parameters was therefore deduced, by a least-squares analysis, which gave this preferred value of σ_γ and fitted the shape of the total cross-section curve. To obtain this fit it was necessary to re-normalize the curve of σ_T by 4%. The new parameters are listed, and a discussion of the probable accuracy of the data is included. (auth)

33782 (CEA-1996) ÉTUDE THÉORIQUE DE LA DIFFUSION PARAMAGNÉTIQUE DES NEUTRONS (THÈSES). (Theoretical Study of the Paramagnetic Scattering of Neutrons (thesis)). Daniel Saint-James (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). 1962. 150p.

Submitted to Université, Paris.

General paramagnetic scattering of neutrons is investigated in the situation where the orbital moment of the magnetic scattering ions is not quenched. The general, relevant expression of the cross-section is given. The preceding results are applied to rare earths and Fe-group ions. It is shown that if crystalline actions lift the free ion ground state degeneracy, the neutron may induce transitions between the various levels, the distances of which are typically of the order of several hundred cm^{-1}. The various scattering cross-sections (elastic and inelastic) are calculated for the rare earths in a cubic crystalline field, for the Ho and Er sesquioxides and for the anhydrous iron chloride (Cl_2Fe). These cross-sections are high enough to allow for an experimental detection, thus providing a direct determination of the levels distances through the measurement of the neutron wave-length shift. It is also shown that, for Nd, Ho, and Er, the total cross-section for neutrons of one angström wave length is rather insensitive to the crystalline field effects. The results are compared with the available experimental studies. The effects of the orbital moment on the angular dependence of the scattering for polarized ions is investigated. The well-known formula: $I = I_0 \sin^2\beta$ is only an approximation, the validity of which is discussed. (auth)

33783 (IDO-16758) 650 SOFOCATE — A CODE TO DETERMINE THERMAL CONSTANTS ON THE IBM-650. R. J. Wagner (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Mar. 30, 1962. Contract AT (10-1)-205. 41p.

650 SOFOCATE is an IBM 650 code to determine the macroscopic thermal cross sections to be used in reactor diffusion and transport codes. These thermal constants are derived by averaging energy dependent cross sections over either a Wigner-Wilkins or a Maxwellian spectrum. As the name implies, the 650 SOFOCATE code is essentially a recoding of the 704 code, SOFOCATE, programmed by Westinghouse. The procedure of obtaining the spectrum, and the averaging of the cross sections over the spectrum follows exactly the procedure outlined in WAPD-TM-39. Restrictions of the 650 version to the 704 code are that the energy limit of the spectrum is reduced from 2.00 to 1.09 ev, and that no provision is made for an energy dependent moderator cross section and logarithmic energy decrement. In addition to the macroscopic cross sections used in diffusion codes, D, Σ_A, and $\nu\Sigma_F$, the 650 SOFOCATE generates cross sections used in transport codes, Σ_{TR} and Σ_S. The 650 version allows the user the option of specifying whether the energy dependent macroscopic cross sections, derived from the specified material composition, are to be averaged over either a Wigner-Wilkins spectrum generated from the same composition, or a Maxwellian spectrum, or a Wigner-Wilkins spectrum generated by a different material composition. The latter is useful in determining homogenized cell constants. A description of the code and the equations and procedures used are presented. A description is also given of a procedure for calculating thermal constants for a thin heavily absorbing region. (auth)

33784 ABSORPTION OF NEUTRONS EMITTED FROM A FAST-NEUTRON SOURCE BY CADMIUM AND INDIUM PLATES PLACED IN AN AQUEOUS MEDIUM. V. A. El'tekov and Yu. S. Ryabukhin. At. Energ. (USSR), 13: 266-9(Sept. 1962). (In Russian)

Following up previous work on the In–Ga loop of the IRT reactor, involving the estimation of the activation of the In–Ga alloy, a supplementary problem was considered. It consisted of the calculation of the absorption probability of the neutrons emitted by a flat, infinite, and uniform fast neutron source in a parallel layer which was black for the slow but transparent for the fast neutrons. The validity of the derived formula was experimentally verified in an arrangement consisting of a 80-cm diameter cylindrical container filled to a height of 85 cm with a 12% solution of $MnSO_4$: a vertical Al pipe in the middle of the cylinder could be filled with a Ra–α–Be or Po–α–Be source. The cylinder was surrounded with a 10-cm thick paraffin layer. Absorbing foils were placed symmetrically at the sides of the sources. The absorption probability which was the same for point and surface sources, was calculated from the absorption in the solution with and without the absorbing layers. The experimental values were found to be lower than expected from theory. From these data the average

γ dose of the irradiator in the loop of the RK-1 reactor was calculated, using the method described by A. Kh. Breger (Paper No. 80 presented at the International Conference on Strong Radiation Sources, Warsaw, 1959). (TTT)

33785 TRAPPING OF THERMAL NEUTRONS. II. MISCELLANEA. Masuhiko Otsuka (Electric Power Development Co., Ltd., Japan). Nippon Genshiryoku Gakkaishi, 4: 505-10(Aug. 1962). (In English)

With the help of the formula obtained in Part I, the effects of mixing H_2O and D_2O are examined. The maximum trapping factor as well as the optimum radius of the mixture varies monotonically with the mixing ratio. Contrary to the mixing case, D_2O surrounded by a H_2O layer as a blocking layer for trapped thermal neutrons will give a higher trapping. A central cavity in a trapping medium can hardly enhance the trapping effect. Effects of a reflector enclosing an active shell are discussed. A thick D_2O reflector will be most effective in view of criticality, provided that the active shell is thin enough. In a trapping medium, the fast neutron importance rather than the thermal importance will be affected by the existence of a reflector. (auth)

33786 ON THE PROBLEM OF THE SCATTERING OF A NUCLEON BY THE BOUND STATE OF TWO OTHERS. V. F. Kharchenko (Kharkov State Univ.). Ukr. Fiz. Zh., 7: 573-81(June 1962). (In Ukrainian)

Neutron scattering by a deuteron is considered on the basis of Faddeyev's equations allowing for spins and isotopic spins in the case of central forces. In the case of the total spin of the system $S = \frac{1}{2}$ Schroedinger's equation is reduced to four integral equations, and in the case of $S = \frac{3}{2}$ to two integral equations. As an illustration, the case is considered when the interaction between the nucleons is described by a non-local Yamaguchi potential. (auth)

33787 SCATTERING OF SLOW NEUTRONS BY MOLECULAR GASES. George W. Griffing (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). IAEA Preprint No. SM-30/44. 28p. (TID-16802)

To be published in IAEA Proceedings of the Symposium on Inelastic Scattering of Neutrons in Solids and Liquids, held in Chalk River, Canada, 10-14 September 1962.

Slow neutron scattering by molecular gases is discussed. The most detailed comparison between theoretical and experimental results was on gaseous methane which shows conclusively that the quantum nature of the rotational levels must be explicitly taken into account to obtain agreement with the experimental results. It is also shown theoretically that interference scattering, that is interference scattering between two distinct atoms of the molecule, has an effect which can be observed. This effect was observed experimentally in methane and apparently also for propane. The theory makes quite definite predictions at smaller momentum transfers than was measured. Thus experiments at smaller momentum transfers are needed. (auth)

Nuclear Properties and Reactions

33788 (BAW-1244) RESONANCE ABSORPTION IN U^{238} METAL AND OXIDE RODS. Final Report. W. G. Pettus, M. N. Baldwin, and C. Samuel (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). Apr. 1962. Work performed under United States–Euratom Joint Research and Development Program. Contract AT(30-1)-2576. 103p. (EURAEC-396)

The effective resonance integral was measured for U^{238} metal and oxide rods of various diameters. Three different experimental methods—activation, static reactivity, and oscillation—were used, and the following consistent results were obtained: U^{238}: $RI = 2.4 + 26.2\sqrt{S/M}$ and $U^{238}O_2$: $RI = 0.8 + 28.2\sqrt{S/M}$. The Doppler broadening effect was measured up to 600°C for U^{238} and up to 1000°C for $U^{238}O_2$. The results are in good agreement with the previous measurements of Hellstrand. Measurements of the Dancoff effect for both H_2O- and D_2O-moderated lattices are consistent with the Bell approximation. (auth)

33789 (BNL-5366) THE USE OF LITHIUM-6 DEUTERIDE AS A SOURCE OF 14-Mev NEUTRONS IN A NUCLEAR REACTOR. Allen J. Weiss, Walter D. Tucker, and Louis G. Stang, Jr. (Brookhaven National Lab., Upton, N. Y.). Mar. 1961. Contract [AT-30-2-GEN-16]. 20p.

Lithium-6 deuteride was prepared and irradiated with thermal neutrons to produce a flux of 14-Mev neutrons, by the $Li^6(n,t)He^4$ and $D(t,n)He^4$ reactions. The flux produced was determined by measuring the Sc^{48} activity induced in a vanadium monitor. The best ratio of fast to thermal flux obtained was 7×10^{-5}. The fast neutron flux obtainable with Li^6D compared favorably with that obtained by other methods. (auth)

33790 (CEA-2135) MESURES DES SECTIONS EFFICACES D'ÉCHANGE DE CHARGE ET DE DISSOCIATION DES IONS H_2^+ DANS UNE LARGE GAMME D'ÉNERGIE (25–250 kev) (theses). (Measurements of the Charge Exchange and Dissociation Cross-Sections of the H_2^+ Ion in a Wide Energy Range (25–250 kev) (thesis)). Joseph Guidini (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucléaires, Saclay). 1962. 59p.

Submitted to Université de Paris.

The dissociation, ionization, and charge exchange cross sections of molecular hydrogen ions H_2^+ passing through various gases, were measured as a function of the energy of the ions. The energy range studied was from 25 to 250 kev. The reaction products, analyzed by a magnetic field according to their e/m ratio, were collected on scintillation detectors. Two methods made it possible to separate the various reactions leading to the formation of particles having the same e/m ratio. The first separates the particles according to their energy, the other selects those arriving simultaneously on two different detectors. The results showed a large variation in the charge exchange cross section with the energy of the H_2^+ ions. The variations in the dissociation and ionization cross sections were less pronounced. For a given energy, the values of the cross sections increased with the atomic weight of the target particles. These measurements were extended to the case of H_2^+ ions passing through a target of charged particles. Preliminary results showed an increase in the cross sections as compared to the preceding case. The scattering of the reaction products was studied; this scattering was due to the fact that the molecules formed during a reaction are in an unstable state and the nuclei or atoms diverge from each other. (auth)

33791 (KR-26) THE SCATTERING OF SLOW NEUTRONS BY DIATOMIC MOLECULES. Joergen Loevseth (Norway. Inst. for Atomenergi, Kjeller). June 1962. 29p.

The derivation of the formulas for neutron scattering by homo-nuclear diatomic molecules using the Fermi pseudopotential in conjunction with the Born approximation is outlined. The quantum mechanical state of the system before and after the interaction was taken into account. Numerical results are presented for H_2, D_2, N_2, and O_2 and compared with available experimental data. The properties of H_2 and D_2 as cold moderators are discussed. Two possible sets of values for the spin dependent scatter-

ing lengths of nitrogen were obtained by fitting the theoretical curves to the experimental data, $2a_+ + a_- = (2.47 \pm 0.03) \cdot 10^{-12}$ cm and $a_+ - a_- = \pm(0.73 \pm 0.10) \cdot 10^{-12}$ cm. The magnetic scattering from the O_2-molecule was determined by subtracting the calculated nuclear scattering from the experimental values of the total cross section. (auth)

33792 (ORNL-TM-383) CROSS SECTION PROGRAM AT ORNL, MARCH 1, 1962 TO OCTOBER 1, 1962. H. B. Willard and J. A. Harvey (Oak Ridge National Lab., Tenn.). Oct. 30, 1962. Contract W-7405-eng-26. 12p.

The cross section program at ORNL for the period March 1, 1962, through October 1, 1962, is reviewed. (auth)

33793 (PAN-325/VII) CALCULATION OF THE ROTATION GAMMA VIBRATION INTERACTION IN THE RARE-EARTH NUCLEI. Vojislav Radojević, Adam Sobiczewski, and Zdzisław Szymanski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). May 1962. 14p.

The interaction of the rotation with the γ-vibration of a nucleus is calculated in the rare earth region on the basis of a wave function that takes into account a pairing interaction through the "superconductivity" formalism. The results appear to be in good agreement with the experimental data with the exception of the Os– isotopes. (auth)

33794 (TID-16748) (d,He^3) REACTIONS ON F^{19} AND Al^{27}. B. Zeidman and T. H. Brain (Argonne National Lab., Ill.). June 1962. Contract [W-31-109-eng-38]. 4p. (UAC-6521)

The angular distributions of the $F^{19}(d,He^3)O^{18}$ and $Al^{27}(d,He^3)Mg^{26}$ reactions initiated by 21.6 Mev deuterons were measured. The groups observed from the F^{19} target correspond to energies of excitation in O^{18} of 0, 1.98, 3.68, 4.45, 5.43, 6.32, 7.0, and 8.0 Mev. The groups from the Al^{27} target correspond to excitations in Mg^{26} of 0, 1.83, 2.94, 4.35, and 5.6 Mev. Other data are also given along with interpretive comment. (J.R.D.)

33795 (TID-16852) IONIZATION AND CHARGE TRANSFER CROSS SECTIONS. Technical Status Report No. 12, June 1, 1962 to August 31, 1962. D. W. Martin, J. W. Hooper, D. S. Harmer, and R. A. Langley (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Sept. 1, 1962. Contract AT(40-1)-2591. 13p.

Measurements are being made of the cross sections for production of slow positive ions and free electrons in gaseous targets by fast hydrogen and helium ions and atoms with energies in the range of 0.15 to 1.10 Mev. The cross-section measurements for incident protons on H_2 and He agreed with previous results for the production of slow positive ions but did not agree for production of electrons. It was concluded that the excess electrons were fast electrons coming into the chamber from the beam entrance aperture. Further tests were made using potentials on the electron collector of less than 100 volts, corresponding to smaller collection fields than previously used. This allowed most of the fast secondaries to pass completely through the sensitive volume without sufficient deflection to reach the collector. In these tests the cross sections obtained were in satisfactory agreement with older results. Preliminary results for He^+ incidents on H_2, He, and Ne were rechecked. Design of the charge exchange cell and beam analyzer for extension of the measurements to He^{2+} and H projectiles was completed. (M.C.G.)

33796 (UCRL-10434) THEORY OF ALPHA DECAY. W. Tobocman (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1962. Contract W-7405-eng-48. 12p.

The relationship between nuclear reactions and nuclear decay derived by F. T. Smith is presented and illustrated by a simple example. (auth)

33797 FRACTION OF ESCAPE OF THE YIELDS OF THE $Li^6(n,\alpha)H^3$ REACTION PRODUCED IN NUCLEAR EMULSION AND MEASUREMENT OF THE ABSOLUTE NEUTRON FLUX. J. Casanova (Facultad de Ciencias, Valencia). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 58: 107-18(Mar.-Apr. 1962). (In Spanish)

A theoretical method is presented for the calculation of the escape fraction in $Li^6(n,\alpha)H^3$ reactions produced by a neutron beam entering a photographic plate at 0° angle. The possibility of applying photographic plates loaded with Li^6 to the determination of absolute neutron flux is shown. (auth)

33798 ON THE THEORY OF NUCLEAR REACTIONS. R. Lipperheide (Univ. of California, Los Angeles). Ann. Phys. (N. Y.), 17: 114-58(Jan. 1962).

A system of equations for the description of nuclear reactions is derived, in which rigorous account is taken of the effects of the recoil of the target nucleus, the presence of hard cores in the two-body interactions and the exclusion principle. Elastic and inelastic scattering processes are described in terms of "equivalent potentials." The relation between the equivalent potential in the elastic channel and the optical model potential is established. A self-consistent scheme for the approximate calculation of the phenomenological optical model potential is proposed. (auth)

33799 THE YIELD OF γ-RAY RADIATIVE CAPTURE FROM IRON. A. T. Bakov, S. P. Belov, U. A. Kazanski, and V. I. Popov. At. Energ. (USSR), 13: 31-7(July 1962). (In Russian)

A method of measurement is reported for the determination of the yield of capture gamma rays from the surface of the iron shield of a neutron reactor by a single-crystal scintillation gamma spectrometer. The results of these measurements on the capture gamma rays of iron were normalized to an energy of 7.5 Mev over the range of 5 to 10 Mev. Measurements were carried out for the spectra of capture gamma rays produced over the total energy range of neutrons from a Po-Be source. It is shown that the yield of capture gamma rays is dependent on the thickness of the shield. The effect of boron concentration in the flux on the yield of capture gamma rays was also investigated. It is pointed out that in order to make a quantitative estimate of the gamma quanta emitted from the shield it is necessary to know the energy and the relaxation range of neutrons in the shield, the cross section of radiation and absorption, and the dependence of these parameters on the energy of the neutrons, the spectra, and degree of relaxation of the capture gamma rays. It was also noted that there is a dependence of the spectra of capture gamma rays on the energy of the absorbed neutrons. Empirical observations of the spectra of capture gamma rays and the variation in this spectra as it is affected by the presence of boron carbide and of water reflectors were evaluated. A theoretical discussion and subsequent evaluation of certain parameters, range and distribution, involved in the calculation of capture gamma rays were made. The various arrangements of the source units, shield material, water reflectors, boron carbide absorbers, and methods for standardizing the spectrometer and diminution of background are also described. (TTT)

33800 SCATTERING OF FAST NEUTRONS BY NUCLEI. G. N. Lovchikova. At. Energ. (USSR), 13: 60-1 (July 1962). (In Russian)

Knowledge of the elastic cross sections of structural

materials and of the angular distribution of elastically scattered particles is important for calculating the critical dimensions of reactors and the spatial energy distribution of neutrons in the core and the reflector. The angular distributions of 90-kev neutrons on Ni, Si, and O were therefore measured, using a circular geometry. Neutrons from the $T(p,n)He^3$ reaction scattered by the element under study were recorded by a hydrogen chamber which was shielded by a paraffin screen from the unscattered flux. Cast Ni and powdered Si were used as scatterers together with SiO_2 for O. The following nuclear-physical parameters were determined: total elastic cross section σ_s, the average cosine of the elastic scattering angle $\bar{\mu}$, and the transport cross section of elastic scattering σ_{tr}. (TTT)

33801 INTERACTION OF FAST NEUTRONS WITH URANIUM AND THORIUM NUCLEI. N. V. Kozlova and L. N. Yurova. At. Energ. (USSR), 13: 62-3(July 1962). (In Russian)

A reactor neutron beam was used for studying the interaction of fast neutrons in the energy range of 3.5 to 13.5 Mev, using spheric U or Th scatterers and recording the neutrons on a 100-mm thick nuclear emulsion. The angular scatter of the incident neutrons was ±3°; that of the secondary neutrons 6°30′. The measurements involved the determination of the secondary neutrons of the reactor neutron beam scattered by Th or U, measuring the background neutron spectrum without the scatterer followed by determination of the flux of primary neutrons from the reactor. Thus, secondary neutron spectra were obtained under 30, 45, 60, 90, 120, and 150° for U and under 30, 60, 90, 120, and 165° for Th. The data were used for calculating the differential interaction cross section of U and Th with primary neutrons was calculated for the 4, 5, and 6 Mev range. Total cross sections were also calculated in the 30 to 150° range. The results showed the basic features of elastic scattering phenomena; the contribution of fission and inelastic scattering processes were found to be quite small at the energy levels examined. The data agree well with available results in the 4 to 12-Mev region. (TTT)

33802 COMPARISON OF THE AVERAGE KINETIC ENERGIES OF THE FRAGMENTS FROM THE FISSION OF URANIUM-235 DUE TO THERMAL NEUTRONS AND TO 15-Mev AVERAGE ENERGY NEUTRONS. V. N. Okolovich and G. N. Smirenkin. At. Energ. (USSR), 13: 64-5(July 1962). (In Russian)

It is at present assumed that the average kinetic energy E_k of the fission fragments is determined primarily by the Coulomb repulsion forces at the time of the fission, being also weakly influenced by the excitation energy E_x of the fissioning nucleus. It was shown earlier (Atomnaya Energiya. 12: 461 (1962) No. 6) that the E_k remains the same in the case of fission of U^{235} by thermal and 5-Mev neutrons. This work was extended to neutrons with higher energy; an ionization chamber containing A + 3% CO_2 and a 128-channel analyzer were used for the measurements. The fast neutrons were obtained by bombarding a heavy tritium target with 2.2-Mev deuterons. It was found that the E_k of the fragments resulting from fission due to the 15-Mev neutrons was by 1.5 ± 0.3 Mev lower than that of the fragments originating from thermal neutron induced fission, thus disagreeing with the data reported by P. Stevenson et al. (Phys. Rev., 117: 186 (1960)). These results are difficult to interpret because in case of bombardment with 15-Mev neutrons (n,n′f) and (n,2n′f) reactions take place together with fission; they might be due to the thermal expansion of the nucleus and the increase of the portion of symmetric fission, during which a substantial reduction of the kinetic energy is noted. (TTT)

33803 THE YIELD OF NEUTRONS FROM THE (α,N) REACTION ON Be, B, C, O, F, Mg, Al. Si, AND GRANITE WITH POLONIUM ALPHAS. G. V. Gorshkov, V. A. Zyabkin, and O. S. Tsvetkov. At. Energ. (USSR), 13: 65-7(July 1962). (In Russian)

Using ampules of polonium uniformly packed with each of the irradiated elements, the absolute neutron yield of each ampule was measured. A B^{10}-loaded zinc sulfide scintillator was mounted atop a plexiglas light pipe that optically coupled the scintillator to the photocathode of a photomultiplier tube. The detector, amplifier, and discriminator were adjusted to detect the alphas from the capture of neutrons by the B^{10} loading of the scintillator. The bias was set well above pulse heights obtained from the gamma background. The neutron-source ampule was in each case surrounded by a 4 cm thickness of paraffin and the paraffin "container" was placed on top of the scintillator. The source, paraffin moderator, and detector assembly were in turn surrounded by a 25 cm-thick paraffin reflector. The counting was done underground with a 200-meter water-equivalent layer of earth above to reduce cosmic-ray background. Absolute calibration of the detector was accomplished with a number of standard neutron sources, each having a different neutron spectrum. A table of absolute yields with probable errors is given. The overall systematic error is estimated to be less than 6 to 7%. The yield for the Po-Be source, for example, is given as 84.4 ± 0.9 neutrons per 10^6 alphas. Corresponding figures of 73 and 80 neutrons per 10^6 alphas are given by others. (TTT)

33804 PRODUCTS OF THE COMMINUTION OF GRAPHITE BY BOMBARDMENT WITH Sn^+, V^+, AND Mo^+. V. Ya. Dudarev, G. S. Zhdanov, B. A. Alekseev, and K. K. Kasymbekova. At. Energ. (USSR), 13: 184-6(Aug. 1962). (In Russian)

Materials pulverized by bombardment of graphite in 10^{-6} mm vacuum with 30-kev singly charged Sn, V, and Mo ions were subjected to x-ray diffraction studies. In the Sn + C system only the lines of white tin could be found, together with an increased diffuse background radiation. This was to be expected as Sn does not form carbides. The deposit from the V + C system consisted of a very hard, adherent powder, which scratches glass and is resistant against strong acids. X-ray diffraction revealed the lines of the monocarbide VC, without any graphite lines and with a strong diffuse background indicating the presence of amorphous carbon. The Mo + C system did not present any lines of the pure components but the high-intensity background contained 10 weak diffuse lines which indicated a lattice with a parameter of a = 4.25 kX. This value agrees well with the structure of a Mo monocarbide having an a = 4.27 kX, reported by H. Novotny and R. Kieffer (Zeitschr. f. anorg. u. allgem. Chem., 267: 261 (1952)). (TTT)

33805 MEASUREMENT OF THE EMANATION CONTENT BY THE FILTER METHOD IN VENTILATED ROOMS. S. A. Klyugin, M. Z. Shtal', and N. V. Sobol'. At. Energ. (USSR), 13: 189-91(Aug. 1962). (In Russian)

Ventilation of buildings causes a marked shift in the equilibrium of the daughter products from the decay of radon; calculation of the emanation on the basis of decay products may yield too low results by one order of magnitude for Rn and 3 order of magnitude for Rn^{220}. The shift can be determined with a relative error of less than 20% from the α-activity of the filter and the concentration of the emanation in the air if the exhaust velocity through the filter and the duration of the ventilation are known. A nomograph was constructed, allowing determination of the necessary data under field conditions. The method may be also used for the measurement of the Rn^{220} concentration below 10^{-12}

curie/liter which is especially useful in view of its short half life of 54.5 seconds. (TTT)

33806 MEASUREMENT OF THE SLOWING-DOWN LENGTH OF FISSION NEUTRONS IN SINTERED BeO AT ENERGIES UP TO 1.44 AND 0.3 ev. I. F. Zhezherun, I. P. Sadikov, and A. A. Chernyshov. At. Energ. (USSR), 13: 258-64(Sept. 1962). (In Russian)

A mean square of the neutron slowing-down length L_t^2 affects strongly the critical mass of BeO moderated reactors. As there are no precise data available on the subject, an attempt was made to measure $L^2_{t\ 1.44\to 0.3}$ at energies of 1.44 and 0.3 ev while examining more closely the character of the slowing-down process in this energy range in which the chemical bond of the atoms is not very strong. Cold-pressed and sintered BeO compacts, having a density of 2.79 g/cm^3 were used for the tests, carried out by means of a U converter placed in the thermal column of the IRT-1000 reactor, serving as the neutron source. The value of L_t^2 at 1.44 and 0.3 ev was found to be 92 ± 1.5 and 104 and 2 cm^2, respectively. Functions were derived, showing the effect of the slowing-down density; the theoretical findings agreed well with the experimental measurements. (TTT)

33807 THE γ-RADIATION OF CESIUM-139. V. A. Aksenov, E. B. Brodkin, A. V. Bushuev, and V. I. Polikarpov. At. Energ. (USSR), 13: 271-4(Sept. 1962). (In Russian)

With the exception of a paper by D. Perkins and R. King (Nucl. Sci. Eng., 7: 3(1958)) there are no data available on the energy level of the γ radiation of Cs^{139} although such data are needed for evaluating the background in control systems and for determining the leak tightness of the fuel element cans; they are of interest also for studying the γ spectrum of short-lived fission products. In order to carry out the measurements, the Cs^{139} must be separated from the accompanying fission products. Kr and Xe were separated by means of filters; they yielded Cs and Rb isotopes as decay products. By suitable choice of the time parameters the Cs^{139} concentration on the filter paper could be substantially increased. A scintillation spectrometer with NaI(Tl) and CsI(Tl) crystal detectors, a photomultiplier and a 100-channel pulse height analyzer were used for the study of the spectrum. The highest intensities were found at the following levels: 0.63 ± 0.03; 1.28 ± 0.03; 1.9 ± 0.08; and 3.40 ± 0.08 Mev. The highest energy line was at 4.28 Mev. The following low-intensity lines were noted: 0.50 ± 0.05; 0.80 ± 0.05 Mev; the forbidden line 0.90 ± 0.05; 1.05 ± 0.05; 1.65 ± 0.10; 1.90 ± 0.05; and 2.08 ± 0.05 Mev. The strong radiation of Ba^{139} and Cs^{138} interfered with measurements below 0.4 Mev. (TTT)

33808 THE SPECIFIC ACTIVITY OF GASES IN FLOW-TYPE CHAMBERS. V. A. Bryzgunov. At. Energ. (USSR), 13: 276-7(Sept. 1962). (In Russian)

Flow-type chambers are quite useful for measuring the specific activity of gases; occasionally they are provided with special reservoirs in which the short-lived isotopes are allowed to decay. In such a case the average concentration of the radioactive gas in the flow-through chamber and its concentration at the outlet side of the chamber must be known. This requires the study of the gas flow through the chamber. The isotopic labeling method was used for investigating the passage of air through a 20-liter chamber, labeling the air stream with a short-lived Ar isotope, recording the passage of the labeled volume. Taking into account the dimensions of the chamber, the volume passing through it, and the decay constants of the gases investigated, the concentrations of the short-lived components of a gas mixture could be thus determined. (TTT)

33809 MASS AND CHARGE DISTRIBUTION STUDIES IN THE FISSION OF Np^{237} AND Pu^{239} BY INTERMEDIATE ENERGY HELIUM IONS. James Allen Powers (Purdue Univ., Lafayette, Ind.). Dissertation Abstr., 23: 462-3 (Aug. 1962).

Mass and charge distributions in the helium ion induced fission of Np^{237} and Pu^{239} were studied. The fission of Np^{237} was carried out at incident helium ion energies of 40.5, 37.5, 32.5, 28.4, 25.0, and 20.0 Mev. The fission of Pu^{239} was induced by 32.0 and 21.5 Mev helium ions. Cross sections for representative fission fragments and information concerning the fission process was obtained. The mass distribution for both isotopes was largely asymmetric. However, the symmetric mode increases rapidly with the energy of the incident probe particle. The charge distribution, confirming previous work, was best explained by the Constant Charge Ratio rule. Comparison of the interaction radius with the compound nucleus theory gave excellent agreement with alpha particle scattering data. The number of neutrons emitted during the fission process was determined.

33810 AN EXPERIMENTAL DETERMINATION OF THE SPIN EXCHANGE CROSS SECTIONS OF Rb^{85}, Rb^{87}, AND Cs^{133}. Henry Warren Moos (Univ. of Michigan, Ann Arbor). Dissertation Abstr., 23: 658(Aug. 1962).

The spin dephasing cross sections of Rb^{85}, Rb^{87}, and Cs^{133} were measured using paramagnetic resonance techniques to examine the Zeeman transitions of the alkalies. The collision frequency was determined from the width of the absorption lines and the density of atoms by comparing the intensity of the signal with a $CuSO_4 \cdot 5H_2O$ crystal in the same cavity. The spin dephasing cross sections of Rb^{85}, Rb^{87}, and Cs^{133} are 2.0, 1.9, and 2.3×10^{-14}cm^2. The 70% probable error is ±20%. The extreme limits of error are felt to be +70% and −90%. The dephasing cross sections were assumed to be the same as the spin exchange cross sections. The thermal relaxation times were measured also, and it was found that they were best explained by the strong exchange coupling and an admixture of a not unreasonable amount of excited p state into the wave function during collision. The thermal relaxation cross section does not contribute significantly to the measured spin exchange cross sections. The technique may be extended to the other alkalies and similar species with net electronic spin.

33811 ELECTRON-NEUTRINO ANGULAR CORRELATIONS IN THE BETA DECAYS OF HELIUM-6 AND NEON-23. Robert L. Burman (Univ. of Illinois, Urbana). Dissertation Abstr., 23: 661(1962)

The electron-neutrino angular correlation coefficients in the beta decays of He^6 and Ne^{23} were determined from measurements of the recoil-ion energy spectra. The angular correlation of the electron and neutrino emitted in a beta decay is apparent in the electron-neutrino energy-angle distribution as a factor $[1 + \lambda(v/c)\cos\theta]$, where the value of the angular correlation coefficient λ depends upon the relative strengths of the interaction invariants present in the beta-decay Hamiltonian. Since the decays of He^6 and Ne^{23} are allowed, nearly pure Gamow-Teller transitions, the angular correlation coefficients lie in the interval $-\frac{1}{3} \leq \lambda \leq +\frac{1}{3}$, where $\lambda = +\frac{1}{3}$ for a pure tensor interaction and $\lambda = -\frac{1}{3}$ for a pure axial-vector interaction. Strong sources of radioactive He^6 and Ne^{23} gases were produced by the reactions $Be^9(n,\alpha)He^6$ and $Na^{23}(n,p)Ne^{23}$. The identification and degree of purity of the gaseous sources was established by comparison of half life values. An electrostatic spectrometer was used to analyze the energies of the recoil ions which were detected in an Allen-type electron multiplier. The measured recoil-ion energy spectra

were compared to theoretically calculated spectra by a least-squares analysis. The results of the analysis were $\lambda = -0.39 \pm 0.05$ for the He^6 decay and $\lambda = -0.37 \pm 0.04$ for the Ne^{23} decay. The results clearly indicate that the Gamow-Teller decay is predominantly an axial-vector interaction. An upper limit of 7% was estimated for the ratio of the strength of the tensor to the axial-vector interaction. It was also estimated that $13 \pm 5\%$ of the recoil ions from the decay of He^6 were doubly-charged.

33812 SCATTERING OF K^- MESONS BY NUCLEI. Jack Harley Hetherington (Univ. of Illinois, Urbana). Dissertation Abstr., 23: 661(Aug. 1962).

The determination of the optical potential expected for previously determined scattering lengths, a calculation of the differential scattering cross section expected for each of the potentials, and a comparison of the cross section with experiment is presented. An interesting application of many-body techniques was found. Use of the zero range scattering matrix to represent scattering from free nucleons allows a relatively straightforward calculation of a bound scattering matrix for K^--nucleon collisions in nuclear matter. To find a finite nuclear optical potential it is assumed that the optical potential at any point in the nucleus is equivalent to the optical potential for nuclear matter with a density corresponding to the nuclear density at that point. Optical potentials were calculated on this basis for mesons in the energy range of 30 to 80 Mev. The potentials approach those derived from the impulse approximation at the very edge of the nucleus where the density is low, but at smaller radii, where the density is greater, the real parts of the potentials may deviate both in character and sign from those given by the impulse approximation. The differential scattering cross section for each of the above potentials was found through an accurate partial wave analysis, and comparison of these cross sections with other data favors the (a+) and (b+) solutions. The cross sections corresponding to either of the (−) solutions are significantly poorer fits although difficulties in the computation of the potential for (b−) do not allow it to be ruled out conclusively.

33813 RADIOACTIVE DECAY OF IRIDIUM^{189}. John Kenneth Lerohl (Ohio State Univ., Columbus). Dissertation Abstr., 23: 661-2(Aug. 1962).

To produce radioactive Ir^{189} a cyclotron bombardment with 10 Mev protons was performed on a target sample of osmium enriched in the isotope Os^{189} to a composition of 87.3%. Also present (8.5% composition) was the isotope Os^{190} which would be expected to react with the protons to produce the Ir^{190} activity with a half life about equal to that of Ir^{189}. A low energy proton bombardment (6 Mev) was performed on an osmium sample enriched to 95% in Os^{190}. The radiations from both bombardments were observed with several types of scintillation detectors and pulse height analyzers and compared over a period of four months. A typical spectrum of radiation from the enriched Os^{190} target showed photo peaks for an x-ray energy of 63 kev, a strong 187 kev gamma ray, and numerous other higher energy gamma rays. The half life was measured to be 12.1 ± 0.2 days. The early radiation from the enriched Os^{190} target contained many gamma rays with a 41-hour half life that was identified as the well-known Ir^{188} decay and therefore attributed to a (p,2n) reaction with the Os^{189}. The spectra of later radiations were compared under identical conditions of source to crystal geometry and analyzer gain settings with the spectra of radiation emitted by the enriched Os^{190} target sample. The Os^{190} target spectrum was then used to subtract from the Os^{189} target spectrum all radiation due to this impurity. The resulting spectrum showed only a strong 63 kev x-ray photo peak and a strong 245 kev photo peak. The spectrum was further unscrambled by subtracting other gamma rays whose energies were previously determined. On the basis of multipolarity assignments and some conversion electron intensities, it was possible to use the gamma ray intensity measurements obtained from the unscrambling calculations and the K and L x-ray measurements to construct a decay scheme for Ir^{189}. The branching ratios and the transition intensities were computed and the excited energy levels of Os^{189} with their spin and parity assignments were proposed. The energy levels were set at 30.9, 69.6, 106, 164, 219, 269, and 275 kev. The half life of the K capture Ir^{189} decay was measured to be 13.3 ± 0.1 days.

33814 NUCLEAR PICKUP REACTIONS AND STUDIES OF He-ION INDUCED REACTIONS IN LIGHT AND MEDIUM WEIGHT NUCLEI. Richard Harold Lindsay (Washington State Univ., Pullman). Dissertation Abstr., 23: 662(Aug. 1962).

A study was made of nuclear pickup reactions and also direct reactions induced by protons, deuterons, and He-ion projectiles in which the exit channels may be reached through single or multi-nucleon pickup reactions. A simple theory leading to the differential form factors for the various reactions is presented. The theory is shown to give fairly accurate angular distributions when compared with recent measurements of (p,d), (d,t), and (d,α) angular spectra. Total cross section measurements and mechanism studies of the (α,Be^7) reaction in the light elements (Al, Mg, Ti, Co, and Cu) were made. The cross sections at 40 Mev He-ion bombarding energy are shown to decrease rapidly with increasing atomic number of the target nuclei. The excitation function data were compared with the predictions of the statistical theory of nuclear reactions for the $Al^{27}(\alpha,Be^7)Na^{24}$ reaction. Yields of both Be^7 and Na^{24} were measured and discussed in terms of other possible mechanisms leading to the residual Na^{24} nucleus (the $Al^{27}(\alpha,\alpha He^3)$ reaction). Bulk laboratory angular distribution measurements of the emerging Be^7 nuclei and more detailed angular spectra work showed the reaction to proceed by a direct interaction mechanism in less than about 40% of the total yield in the 41 Mev He-ion bombardment of aluminum, the principal mechanism in the $Al^{27}(\alpha,Be^7)$ reaction being the evaporation of the heavy particle from a highly excited compound nucleus. A study of the $Al^{27}(\alpha,3p)Mg^{28}$ and $Mg^{26}(\alpha,2p)Mg^{28}$ reactions produced by the bombardment of aluminum and magnesium targets with 42 Mev He-ions was made, and excitation functions from reaction threshold to 40 Mev are given. An investigation of numerous other He-ion induced reactions, particularly (α,αn) reactions in cobalt, nickel, and silver isotopes was carried out and the results discussed in terms of the various possible mechanisms for the reactions. Excitation functions are given for the production of Na^{22} from the bombardment of aluminum with 30-42 Mev He-ions, which proceeds chiefly through the reaction $Al^{27}(\alpha,2\alpha n)Na^{22}$, and of Na^{24} from the bombardment of natural magnesium, primarily through the $Mg^{25}(\alpha,\alpha p)Na^{24}$ reaction. Cross section measurements of the $Ni^{62}(\alpha,n)Zn^{65}$ + $Ni^{61}(\alpha,\ )Zn^{65}$, $Ni^{58}(\alpha,\alpha pn)$, $Co^{59}(\alpha,2pn)$, and $Ag^{107}(\alpha,\alpha 2n)$ reactions are presented and discussed.

33815 BETA-CONVERSION ELECTRON TRANSVERSE POLARIZATION CORRELATION IN Au^{198}. Ralph Alvin Llewellyn, Jr. (Purdue Univ., Lafayette, Ind.). Dissertation Abstr., 23: 662-3(Aug. 1962).

Beta-conversion electron transverse polarization correlation was measured for Au^{198} and Hg^{203}. The experiment

consisted of detecting the beta particle and using a thick lens spectrometer to focus the conversion electrons on a polarization sensitive detector. The detector was made polarization sensitive by observing the electrons after a Mott scattering. The measured asymmetry in the scattered electron intensity was the basis for computing $P_\perp$. The $P_\perp$ values are -0.22 ± 0.03 for Au^{198} and $+0.41 \pm 0.05$ for Hg^{203}. The results agree with the theoretical prediction of the ξ-approximation and with experimental results using other techniques.

33816 THE MÖSSBAUER EFFECT IN IRON-57. Seymour Margulies (Univ. of Illinois, Urbana). Dissertation Abstr., 23: 663(Aug. 1962).

Two aspects of the Mössbauer effect employing the 14.4 kev transition in Fe^{57} are discussed: the detection of the effect, which includes an observation of the Zeeman splitting of the transition; and the broadening of the transmitted Mössbauer line resulting from absorption in a resonance absorber of finite thickness. Radioactive sources were prepared by imbedding Co^{57}, the parent isotope, into an iron backing foil. The presence of the Mössbauer effect was detected by measuring the intensity of 14.4 kev radiation passing through an iron resonance absorber which was moved relative to the source. By measuring the transmission as a function of absorber velocity, a series of resonance lines were observed. This complex pattern indicates the existence of a hyperfine interaction between the magnetic moments of the Fe^{57} nuclei and the internal magnetic field in the iron source backing. To permit a simple analysis, Mössbauer spectra were measured using Type 310 stainless steel and potassium ferrocyanide absorbers. Being non-ferromagnetic, the absorbers had unsplit transition lines, and the resulting transmission patterns corresponded directly to the split emission spectrum. A study of the line spacings in the various Mössbauer patterns yields -0.154 ± 0.007 nm for the magnetic moment of the 14.4 kev level, and $(3.32 \pm 0.07) \times 10^5$ gauss for the value of the internal magnetic field in iron. Assuming Lorentzian emission and absorption spectra, an integral expressing the transmission of resonance radiation from a source of finite thickness through a resonance absorber is presented. The integral is numerically evaluated for uniform and Gaussian distributions of emitting atoms. To increase their usefulness, the calculations are extended to the case of split emission and absorption spectra. In addition, to see the effects of spectral shape, Gaussian emission and absorption lines are considered. The results indicate that the characteristics of the transmitted line are strongly dependent upon the spectral shape. To test the calculations, the transmitted line shape was carefully measured as a function of absorber thickness. The observed line was more than four times wider than the natural width, and was intermediate between Lorentzian and Gaussian in shape. Averaging the results obtained from the Lorentzian and Gaussian analyses yields $f \simeq 67\%$, $f_A \simeq 137\%$ for the source, and absorber recoilless fractions. The anomalously large value of f_A seems to indicate that the conversion coefficient for the transition is not 15, but rather, about 8. Identically split spectra were obtained by using Armco iron for both absorbers and source backing. In this case, the central resonance line was approximately Lorentzian in shape. Applying the Lorentzian analysis results in the values $f = 70 \pm 5\%$, $f_A = 144 \pm 15\%$. Again, f_A can be reduced to a reasonable value by assuming a conversion coefficient of about 8.

33817 A SEARCH FOR GAMMA RAYS RESULTING FROM PROTON CAPTURE IN AND ABOVE THE ENERGY REGION OF THE PHOTONUCLEAR GIANT RESONANCE. Neville William Reay (Univ. of Minnesota, Minneapolis). Dissertation Abstr., 23: 663-4(Aug. 1962).

An excitation function was performed for the reaction $Li^7(p,\gamma)Be^8$ in one Mev steps between 21.5 and 25.2 Mev center of mass excitation energy at target center. In addition, an angular distribution was performed at an excitation energy of 25.2 Mev, containing points at 15° intervals between 45° and 135°. The excitation function indicated the existence of a giant resonance peak for ground state transitions at $22.0 \pm \frac{1}{2}$ Mev, and another peak for excited state transitions at $24.8 \pm \frac{1}{2}$ Mev. Thus, the ground and first excited states are separated by 3.0 ± 0.7 Mev. This separation is approximately equal to the excitation energy of the first excited state, as would be predicted by certain simple theories. Equations are given for fitting the angular distribution in the center of mass system. A survey experiment was performed using the 3.65 Mev beam of lithium ions. An attempt was made to form collective excitations in the compound nuclei formed by the lithium projectiles and the target nuclei; lithium fluoride, beryllium, and boron. No gamma rays containing the total excitation energy of the compound nuclei were seen. Gamma rays in the 16 to 20 Mev range were seen, but were not investigated in detail. An excitation function for the reaction $B^{11}(p,\gamma)C^{12}$ was also performed. Points were taken at intervals of 0.9 Mev or less between compound nucleus excitation energies of 29.7 and 38.7 Mev. The existence of an excited state transition giant resonance at an energy of $3.5 \pm \frac{1}{2}$ Mev above the well known ground state transition giant resonance at 22.5 Mev was indicated. Both the ground and first excited state transitions showed small, broad resonances at excitation energies of $34.4 \pm \frac{1}{2}$ Mev. $\sigma(90°) \times 4\pi = 23$ microbarns for the excited state transition, and 10 microbarns for the ground state transition at the resonance peak. Both resonances have widths of $4.5 \pm \frac{1}{2}$ Mev. The resonances can be explained by particle-hole calculations as being due to partial excitation of a 1^- state theoretically calculated to occur at an excitation energy of 33.5 Mev.

33818 THE SCATTERING OF MONOCHROMATIC GAMMA RAYS BY THE DEFORMED NUCLEUS Ho^{165}. Paul Allen Tipler (Univ. of Illinois, Urbana). Dissertation Abstr., 23: 664(Aug. 1962).

The measurement of the cross section at 135° for scattering of gamma rays by holmium is described. A resolution of 0.6% and a maximum intensity of 10^4 gamma rays per second for each electron detector made it possible to look for structure in the giant resonance, and to compare the scattering cross section with the absorption cross section. The experimental apparatus was improved so that accurate and more detailed data could be obtained. The scattering cross section was measured at 48 energy points with an average precision of about 18%. The results show the following: a definite gross splitting of the giant resonance; no fine structure; agreement in magnitude with the scattering measurement made by others at 90°; agreement with the energy dependence of the absorption data of others; and a slight preference for the three resonance fit to the absorption data over the two resonance fit. Zero point vibrations in the ground state would imply that the scattering data should agree with a three line fit even if there were only two different equilibrium axes.

33819 NEUTRON-CAPTURE GAMMA RAYS OF BROMINE, COPPER, IRIDIUM, NICKEL, AND TUNGSTEN. Paul Albert Treado (Univ. of Michigan, Ann Arbor). Dissertation Abstr., 23: 665(Aug. 1962).

Investigations were undertaken to obtain information about the formation and decay of nuclei occurring as the products in neutron-capture reactions. Samples of natural bromine, copper, iridium, nickel, and tungsten, and separated isotope samples of Br^{79}, Br^{81}, Ni^{58}, Ni^{60}, Ni^{62}, W^{182}, W^{184}, and W^{186} were placed in a neutron beam and their neutron-capture gamma-ray spectra obtained. The energies and intensities of about 100 gamma-ray lines were determined from the spectra. If it is assumed that the maximum observed gamma ray energy for each isotope corresponds to a transition from the capture state to the ground state, then the energy of the transition is equal to the neutron binding energy in the product nucleus. In this way the neutron binding energies were determined. The general shape of the bromine and iridium spectra was in qualitative agreement with that predicted from a statistical model of the nucleus. Intense high-energy lines were observed from the copper, nickel, and tungsten samples, indicating that a direct capture mechanism contributed to the neutron-capture cross section. Also, there was a correlation between the intensities of the high energy lines from copper and nickel and those of the proton groups leading to the same final state in the corresponding (d,p) reaction. The principal contributions to the background were: gamma rays independent of the sample, reactor gamma rays scattered by the sample, and capture gamma rays arising from neutrons scattered by the sample. Experiments were carried out to determine the magnitude and shape of each of the contributions, from which a background spectrum appropriate to each sample was constructed. In supplementary experiments the inherent electronic instability of the detection system was investigated and minimized; the ratio of the neutron flux to gamma-ray flux was measured and optimized; and the efficiency and resolution of the three-crystal spectrometer were determined.

33820 A PROPOSED Ir^{186} ISOMER. N. A. Bonch-Osmolovskaya, K. Ya. Gromov, B. S. Dzhelepov, O. E. Kraft, T. V. Malysheva, L. N. Nikityuk, B. A. Khotin, Chzhou Yue-Va, and V. G. Chumin. Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 975-6(Aug. 1962). (In Russian)

An Ir fraction was isolated from a gold target which was irradiated with 660-Mev protons, and investigated on a triple-focusing spectrometer. Positrons were observed that decayed with a half life of about two hours. The positron spectrum consisted of five components with limiting energies of 3400, 2600, 1930, 1300, and ~800 kev, and with relative intensities of 1, 20, 44, 12, and 22 respectively. In studying the internal electron conversion spectrum of an Ir fraction on a $\pi\sqrt{2}$ spectrometer having a resolution of 0.3%, it was observed that the decrease in intensities of the M 137 and N 137 electron lines (corresponding to the 137 kev γ-transition during the decay of the 15 hour Ir^{186}) consisted of a "long-lived" component with a half life of 15 hours, and of a "short-lived" component with a half life of 1.7 ± 0.2 hours. It is proposed that the 2-hour activity belongs to a new isomer of Ir^{186}. (TTT)

33821 MEASUREMENT OF THE α-PARTICLE ENERGIES OF A NUMBER OF CURIUM ISOTOPES. R. B. Ivanov, A. S. Krivokhatskii, and V. G. Nedovesov. Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 976-8(Aug. 1962). (In Russian)

The α-particle energies of Cm^{242}, Cm^{243}, and Cm^{244} were compared with the α-particle energies of Bi^{212} on a double-focusing, magnetic α spectrometer. The standard α transitions in Bi^{212} were assumed to be 6089.77 and 6050.60 kev (taken from A. Ritz). The spectrum of the Bi^{212} isotope was imposed on a photograph of the alpha spectrum of the curium isotope, and the energies of the α transitions were obtained by comparison with the known α transitions of the Bi^{212} isotope. The α transitions in Cm^{242} were found to be 6071 ± 1 and 6115 ± 1 kev, and also 5971 Mev for the α transition to the 4^+ level of the daughter nucleus (0.035% yield). The α transitions in Cm^{244} were 5763 and 5806 kev, as obtained by comparison with the 5769 kev transition in Bi^{212}. The α transition of Cm^{244} to the 4^+ level of the daughter nucleus turned out to be equal to 5666 kev. The α transitions in Cm^{243} were 5991, 5784, and 5739 kev. (TTT)

33822 GAMMA-RAY AND INTERNAL ELECTRON CONVERSION SPECTRA FROM THE $Cd^{113}(n,\gamma)Cd^{114}$ REACTION. L. V. Groshev, A. M. Demidov, V. N. Lutsenko, and V. I. Pelekhov. Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 979-92(Aug. 1962). (In Russian)

A 350 gram sample of metallic cadmium (natural mixture of isotopes) was irradiated in a reactor with slow neutrons. A total of 132 lines was separated from the γ spectrum. The energy and intensities of the line per neutron capture are presented. A cadmium oxide target 0.8 mg cm^{-2} thick, enriched with 85% Cd^{113}, was irradiated in order to obtain the internal electron conversion spectrum from 20 to 3000 kev on a magnetic spectrometer. The intensity, internal conversion coefficient at the K-shell α_K, and type of transition are listed for about 25 internal conversion electron lines. A diagram of the γ transition of Cd^{114} is given. On averaging the gamma energies for 60 different cascades, the binding energy of the last neutron in Cd^{114} was found to be 9041 ± 3 kev. The density of levels increased sharply above about 2.5 Mev. Five excitation levels were found at 1.1 to 1.4 Mev. A discussion of the population of various levels, and branching of lower levels is presented. (TTT)

33823 A STUDY OF THE COULOMBIC EXCITATION OF LEVELS IN Fe^{57}, Ge^{73}, Rh^{103}, Pd^{105}, In^{113}, In^{115}, and Sn^{115}. V. D. Vasil'ev, K. I. Erokhina, and I. Kh. Lemberg (Ioffe Inst. of Technical Physics, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 992-7(Aug. 1962). (In Russian)

Fe^{57} was bombarded with 30-Mev nitrogen ions, Ge^{73} with 36-Mev nitrogen ions, and Rh^{103}, Pd^{105}, In, and Sn^{115} with 42-Mev nitrogen ions. Values of the coulombic excitation B(E2) for various nuclear levels were obtained, and the parity, spins, and partial lifetime with respect to the E2-transition were determined. The irradiated enriched Fe^{57} target showed 0.69 and 0.365-Mev γ lines with B(E2)↑ values of 0.008 and 0.026 respectively in units of $e^2\ 10^{-48}$ cm^4. The values of B(E2) for the 1.11 and 0.82 levels in Ge^{73} are 0.030 and 0.035 respectively. The maximum value of B(E2) for the 0.362-Mev level in Ge^{73} is 0.0017×10^{-48} e^2 cm^4, which is a factor of 5 less than the estimate made by Weiskopf. A new 0.84-Mev level in Rh^{103}, which discharges directly to the ground state, gave a value of 0.0045 for B(E2)↑. In Pd^{105} the significant levels were found at 0.78 Mev (0.059), 0.044 Mev (0.21), 0.345 Mev (0.026), and 0.28 Mev (0.013). The value of B(E2)↑ are given in parentheses in units of $e^2\ 10^{-48}$ cm^4. The 1.15 and 0.87-Mev levels in In^{113} gave values of 0.070 and 0.016 for B(E2)↑. The 1.29, 1.15, and 0.935-Mev levels in In^{115} showed values of 0.03, 0.078, and 0.015 for B(E2)↑. In Sn^{115} the 0.51-Mev levels gave a value of 0.015 for B(E2)↑. (TTT)

33824 A STUDY OF THE COULOMB EXCITATION OF THE SECOND LEVEL $2^{+'}$ OF Pd^{104}. V. D. Vasil'ev, Yu. P. Gangrskii, K. I. Erokhina, and I. Kh. Lemberg (Ioffe Inst. of Technical Physics, Academy of Sciences, USSR). Izv.

Akad. Nauk SSSR, Ser. Fiz., 26: 997-9(Aug. 1962). (In Russian)

An enriched target of Pd^{104} (containing 6% Pd^{105}) was bombarded with 42-Mev nitrogen ions. A 0.78-Mev γ line, which is due to the transition between the 1.34 and the 0.56-Mev levels in Pd^{104} was observed, but the direct transition from the 1.34-Mev excited $2'^{+}$ level could not be observed because of the 1.37-Mev gamma from the N + C reaction. The yield of excitations to the 1.34-Mev level was estimated by calculation to be 35% of the total number of excitations. The value of the $B(E2)_{0\to 2'}$, excitation of the 1.34-Mev level in Pd^{104} was then calculated to be 0.015×10^{-48} e^2 cm^4. This value agrees with the estimate of Weiskopf (single-particle model). The lifetime of the 1.34-Mev level was calculated as 5.8×10^{-12} sec. The measurement error was 35%. (TTT)

33825 THE LIFE-TIME OF THE FIRST LEVEL IN Ti^{50}. V. D. Vasil'ev, K. I. Erokhina, and I. Kh. Lemberg. Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 999-1001(Aug. 1962). (In Russian)

A target of metallic titanium, enriched to 58% Ti^{50}, was bombarded with 30-Mev nitrogen ions. The area under the 1.58-Mev gamma peak was estimated in order to calculate a value of 0.040×10^{-48} e^2 cm^4 for the first excited level in Ti^{50}. The lifetime of this state was 1.03×10^{-12} sec. On comparing the energy levels in Ti^{46}, Ti^{48}, and Ti^{50}, it was observed that on going from Ti^{46} to Ti^{50} the number of neutrons increases from 26 to 28, and the energy of the first level increases sharply from 0.99 Mev in Ti^{48} to 1.58 Mev in Ti^{50}, while the value of B(E2) drops sharply from 0.070 for Ti^{48} to 0.040×10^{-48} e^2 cm^4 for Ti^{50}. (TTT)

33826 COULOMB EXCITATION OF THE SECOND LEVEL IN SPHERICAL EVEN-EVEN NUCLEI. Yu. P. Gangrskii and I. Kh. Lemberg (Ioffe Inst. of Technical Physics, Academy of Sciences, SSSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 1001-14(Aug. 1961). (In Russian)

In spherical even-even nuclei, the second 2^+ level is a factor of 2 to 2.5 higher than the energy of the first 2^+ level. Since the cross section for excitation of the second level is low, coincidence gamma counting must be used to determine the cascade gammas. On obtaining the coincidence spectra, the energies of the first and second 2^+ levels can be determined, and the probabilities for the cascade transition to the ground state can be calculated. Corrections must be made for inelastic scattering and double coulomb excitation, but these effects are small when N^{14} ions are used to bombard the target. Data are presented on the excitation of the second level in the even-even isotopes of germanium, selenium, molybdenum, palladium, and tellurium on being bombarded with nitrogen ion having energies of 36 to 53 Mev. The energy values of the first and second excitation levels, and values of the $B(E2; 0 \to 2)$ and $B(E2; 0 \to 2')$ are given. The lifetimes of the transitions from the second 2^+-levels are also presented. (TTT)

33827 THE ANGULAR DISTRIBUTION OF γ-RADIATION EMITTED FROM THE FIRST EXCITED LEVEL OF Ti^{47} AND V^{51}, AND FROM THE 246 kev LEVEL OF Se^{77}. G. M. Gusinskii, I. Kh. Lemberg, and Z. Treibal (Ioffe Inst. of Technical Physics, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 1014-18(Aug. 1962). (In Russian)

A target 6 × 6 mm was irradiated with a beam of 16.5-Mev or 18.3-Mev triply-charged nitrogen ions. The angular distribution of γ quanta emitted as a result of coulombic excitation was determined simultaneously on four scintillation detectors placed at angles of 0°, 30°, 60°, and 90° with respect to the beam of nitrogen ions. The coefficients of the γ-γ correlations of a hypothetical γ cascade of the form $I_1(E2)\ I_2(E_2 + M1)\ I_3$ were determined experimentally. Here I_1 is the spin of the ground state, I_2 is the spin of the excited state, and I_3 is the spin of the final state of the nucleus ($I_3 = I_1$ in these experiments). On the basis of the experimentally determined angular distribution of gamma rays, it was concluded that the first, excited, 160-kev level in Ti^{47} has a spin and parity of $(\frac{5}{2})^-$. The lifetime $\tau(E2)$ is 19.5×10^{-2} sec. The ratio of the intensities $|\delta|^2$ of the E2 and M1−transitions is given by the formula: $|\delta|^2 = \tau/[\tau(E2) - \tau]$. The value of $|\delta|$ for Ti^{47} is 0.129. The first, excited, 323-kev level in V^{51} has a spin and parity of $(\frac{5}{2})^-$. The value of δ is 0.51. The lifetime of the 323 kev level is 2.75×10^{-10} sec. The spin and parity of the 246-kev level in Se^{77} were found to be $(\frac{3}{2})^-$. The value of δ is +0.19. (TTT)

33828 THE DECAY SCHEME OF Tm^{167}. K. Ya. Gromov, B. S. Dzhelepov, V. Zvol'ska, I. Zvol'skii, N. A. Lebedev, and Ya. Urbanets. Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 1019-26(Aug. 1962). (In Russian)

A rare earth fraction was separated from a Ta target bombarded with 660-Mev protons. Pure Tm^{167} was isolated by separating out the lutecium fraction and allowing Tm^{167} to grow in. The γ spectrum of Tm^{167} was investigated on a 100 channel, scintillation spectrometer. Only the 57, 208, and 532-kev γ lines were moted in the spectrum. The conversion electron spectrum of Tm^{167} was studied on a β spectrometer with double focusing at an angle of $\pi\sqrt{2}$. The conversion electron energies were found to be 57.15, 207.9, and 531.8 kev. The 57.15-kev transition is a transition of the type M1(87.5%) + E2(12.5%). The 207.9-kev transition is an E3 transition. The 531.8-kev transition is either a pure E2-transition, or an E2 transition with an admixture of a M1-transition (<32%). The presence of a coulombic excitation level in Er^{167} having an energy of 531.8 kev showed that the 531.8-kev transition in Tm^{167} goes directly to the ground state of Er^{167}. The 531.8-kev level has a spin and parity of $(\frac{3}{2})^+$. The 531.8-kev level is not a single-particle level, but is a collective oscillatory level. (TTT)

33829 THE COULOMBIC EXCITATION OF THE 532 kev LEVEL IN Er^{167}. Yu. P. Gangrskii and I. Kh. Lemberg. Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 1027-8(Aug. 1962). (In Russian)

An enriched target of Er^{167} was bombarded with 50-Mev N^{14} ions. The γ quanta emitted as a result of coulombic excitation were counted in coincidence with the inelastically scattered N^{14} ions in order to increase the sensitivity of the measurements. The γ quanta were recorded on a scintillation spectrometer, and the inelastically scattered N^{14} ions were counted by a silica p-n semiconductor. A 532 kev γ line, which discharges directly to the ground state, was found in Er^{167}. The value of B(E2) for the excitation of the 532-kev level was found to be 0.042 e^2 10^{-48} cm^4. If the spin is equal to $\frac{7}{2}$ for this level, the lifetime of this excited state is 2.3×10^{-11} sec. This lifetime is a factor of 12 less than the value calculated by the formula of Weiskopf. In the decay of Tm^{167}, the 532-kev γ line goes directly to the gound state of Er^{167}. (TTT)

33830 THE MULTIPOLARITIES OF THE 208 AND 532 kev γ-TRANSITIONS IN Er^{167}. O. D. Kovrigin, Yu. A. Andreev, V. M. Kartashov, G. D. Latyshev, G. I. Sychikov, and A. G. Troitskaya. Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 1028-30(Aug. 1962). (In Russian)

A thulium fraction was isolated from a Ta target irradiated with 680-Mev protons. The conversion electron spectrum of Tm^{167} was studied on a double-focusing β spec-

trometer in order to determine the L_I^-, L_{II}^-, and L_{III}^- conversion lines for the 208 and 532-kev γ transitions. A comparison of the experimental ratio $L_I : L_{II} : L_{III} = 0.16 : 1 :$ 0.62 with the theoretical ratio showed that the 208-kev transition is an isomeric E3 type. The K, L, and M conversion electron lines were measured for the 532-kev transition. An analysis of the data shows that the 532-kev γ transition has an E1 or E2 multipolarity with a small admixture of M2 and M1 respectively. (TTT)

33831 THE SPECTRA OF INTERNAL CONVERSION ELECTRONS, AND OF POSITRONS EMITTED DURING THE DECAY OF Re^{184}. B. S. Dzhelepov, G. S. Katykhin, V. K. Maidanyuk, and A. I. Feoktistov. Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 1030-4(Aug. 1962). (In Russian)

A tungsten target was bombarded with 13.6-Mev deuterons. After dissolution of the target, a rhenium fraction was isolated and purified by passing a 3N H_2SO_4 solution through a column of a fluorinated polymeric resin (fluororesin-4) impregnated with cyclohexanol. The column was rinsed with 1N H_2SO_4 and 1N HCl, and the Re was eluted with water. The Re activity was mounted on an aluminum foil 5 μ thick. The conversion electrons and beta particles were bent by a magnetic field and sent through two Geiger-Mueller counters in series which were connected for coincidence counting. Internal conversion coefficients are presented with the results normalized for an $\alpha_K = 0.0045$ for the 904-kev γ transition. The 904, 895, 793, and 111-kev transitions are of the E2 type. The half life of Re^{184} was 38 days from the decrease in intensity of the K peaks. The 382, 1098, 1152, and 1162 kev transitions correspond to a long-lived isomeric state of Re^{184} having a half life of 160 to 180 days. (TTT)

33832 THE α-DECAY OF THE NEUTRON-DEFICIENT ISOTOPES OF Po. B. N. Belyaev, A. V. Kalyamin, and A. N. Murin. Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 1034-6(Aug. 1962). (In Russian)

The study of α decay and E-capture for Po isotopes from the Bi(p,xn)Po reaction is made difficult because of the complexity of the decay chains involved. For example, the decay of Po^{199} goes as follows: Po^{199} K/7.4 hrs → Bi^{199} K/ 25 min → Pb^{199} K/90 min → Tl^{199} K/7.4 hrs → Hg^{199} (stable). Po^{201}, which has a known fraction of α decay and of E-capture $\alpha_1/(\alpha + E) = 5\%$, was used as a referee standard of comparison. The fraction of Po nuclei undergoing E-capture was determined by chemical separation of the daughter products (Bi, Pb, and Tl) and counting on a 4 π scintillation counter. On the basis of the latest data, the surface probabilities and reduced widths are calculated for masses 199, 200, 201, and 203. Since the orbital moment of the α particle is not known, it is assumed that L = 0. (TTT)

33833 A STUDY OF THE DECAY SCHEME OF Te^{117}. D. E. Khulelidze, V. L. Chikhladze, N. A. Vartanov, and Yu. A. Ryukhin (Technical Physics Inst. of the Georgian Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 1036-41(Aug. 1962). (In Russian)

A 57% enriched Sn^{114} target was bombarded with 21-Mev α particles in order to produce Te^{117} by a $Sn^{114}(\alpha,n)Te^{117}$ reaction. The Te was separated from the Sn by eluting from a Dowex-1, anion exchanger with 0.1N oxalic acid. The Te activity was mounted on an aluminum foil 5 μ thick. A double-lens β spectrometer and a calibrated scintillation spectrometer (with a 10% resolution for the 0.66 γ line of Cs^{137}) were used for the spectrometric studies. The half life of Te^{117} was determined from the rise and fall of the 160-kev K-conversion line, and was found to be 65 ± 5 min. A Kurie plot of the β^+ spectrum of Te^{117} is a straight line up to H ≈ 3600 oe cm (E ≈ 700 kev) with an upper limit at E 1810 ± 20 kev. A small amount of a 690 kev β^+ may be present. A conversion electron spectrum was taken from 25 to 800 kev. K and L conversion lines from the 720 kev γ-transition were detected at 690 and 716 kev. The K/L ratio = 8.3. The energies and relative intensities of a number of hard gamma lines with a half life of 1.1 hours are given. The number of positrons per decay is 0.31. The value of log ft for the β^+-transition with an upper energy of 1810 kev is 5.3. Hence, this transition is allowed. A decay scheme for Te^{117} is presented. (TTT)

33834 THE POSITRON SPECTRUM OF Ag^{110}. N. B. Badalov, S. S. Vasilenko, M. G. Kaganskii, and D. L. Kaminskii (Ioffe Inst. of Technical Physics, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 1042-5(Aug. 1962). (In Russian)

A pure metallic silver target (99.99% purity) was irradiated with slow neutrons. The Al backing was removed by NaOH, and the positron spectrum of the Ag^{110} activity was investigated on a double-focusing β spectrometer. The positron spectrum was complex in form. Most of the positrons are due to internal conversion with the formation of pairs of γ quanta with energies of 1380, 1480, 1500, 1560, 1780, and 1930 kev. In separating out the partial components of the spectrum, it was assumed that the energy distribution of the positrons can be calculated by a Schroedinger approximation. The relative intensity of the positron components in Cd^{110} was determined by comparison with internal conversion electrons of known intensities. The multipolarities of the three most intense transitions at 1380, 1480, and 1500 kev were determined from the ratio of the coefficients of pair conversion G_P and of electron conversion at the K-shell. The 1380 and 1480 kev transitions are quadrupole with a possibility of a E2 + M1 mixture for the 1380 kev transition. The multipolarity of the 1500 Mev transition is an E2 + M1 mixture. (TTT)

33835 A STUDY OF THE PROPERTIES OF THE TRANSURANIC ELEMENTS. T. Veresh, V. G. Solov'ev and T. Shiklosh (Theoretical Physics Section, United Inst. of Nuclear Physics, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 1045-60(Aug. 1962). (In Russian)

The mathematical methods developed in superconductivity theory were applied to formulate a "superfluid" model of the nucleus. Formulas are presented for finding the constant for pair interaction. Summing was carried out over energies having an average field (over 36 levels). Single-particle levels were calculated for a neutron system and for a proton system in the region of 225 < A < 255. The calculated values of the paired energies were compared with experimental data. The constants for pair interaction are $G_N = 26$ Mev/A and $G_Z = 29$ Mev/A. A table of correlation functions for even systems is given as well as ratios of the correlation functions of excited states to ground states. In calculating the probability of a β transition between single-quasi-particle states in odd nuclei, a correction for the superfluidity $R = R_N R_Z$ was calculated. The theoretical values of log $(ft)_{theor.}$ were calculated and compared with the experimental values. The corrections for superfluidity explain the variations in the magnitude of the values of log $(ft)_{exp.}$ for β transitions between identical states in different nuclei. Values of log $(ft)_{theor.}$ can be calculated between various states in any of the odd nuclei from the data presented. The experimental log (ft) values should be systematized by including the effect of paired correlations and statistical factors. The energies of the ground states and of the two-quasiparticle excited levels in Pu^{240} and Cm^{244} were computed along with values of log $(ft)_{theor.}$ for the corresponding β transitions. The 6^+ level in Cm^{244} was

found to have an energy of 1.042-Mev and a log $(ft)_{exp.}$ = 5.9. These values are in good agreement with the calculated values which give an energy of 0.92 Mev and log $(ft)_{theor.}$ = 6.0. (TTT)

33836 THE LOWER LEVELS OF O^{17} AND F^{17} IN THE α-MODEL OF THE NUCLEUS. Z. Mattkhiz, V. G. Neudachin, and Yu. F. Smirnov (Moscos Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 1060-8(Aug. 1962). (In Russian)

The results on the lower levels in C^{12} and O^{16} confirmed the correctness of an α-model of the nucleus. Calculations of the levels in O^{17} and O^{18} took into account the binding of the residual nucleon with an α-shell structure which has the symmetry of a tetrahedron. In this case, rotational excited states having a small nuclear spin and even a negative parity become possible. The calculations showed that the arrangement of the lower levels in O^{17} and F^{17} are in good agreement with the experimental values. The binding of the nucleon with the shell structure is a weak one. The nucleon bond with the vibration states of the structure plays a noticeable role. The "interaction" of the neutron with the vibration 2^+ level in O^{16} which has an excitation energy of 6.91 Mev results in an effective charge of the neutron which is equal to the experimental value. The calculated values are in good agreement for the states I = $(5/2)^+$, $(1/2)^+$, $(1/2)^-$, $(7/2)^-$, $(3/2)^-$, and $(3/2)^+$. An excitation energy of 5.5 Mev was calculated for the $(5/2)^-$ state, but this line was not found experimentally. The quadrupole moment of the O^{17} ground state was found to be -0.027 barns (the experimental value $Q = -0.026 \pm 0.010$ barns). The lifetime of the first excited $(1/2)^+$ state was calculated as 1.6×10^{-10} sec., while the experimental value is $\tau = 2.55 \times 10^{-10}$ sec. (TTT)

33837 THE MECHANISM FOR THE INTERACTION OF FAST PARTICLES WITH NUCLEI. V. S. Barashenkov and V. M. Mal'tsev (Theoretical Physics Section of the United Inst. of Nuclear Research, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 1069-74(Aug. 1962). (In Russian)

Calculations were carried out on a digital computer for incident 9-Bev protons on an average light nuclei (N^{14}) and on an average heavy nuclei (Nb^{94}). After interaction the particles were separated into three energy groups: s-particles or shower particles (0.5 to 9 Bev for nucleons, and 0.08 to ~8 Bev for π-mesons), g-particles or cascade particles (0.03 to 0.5 Bev for nucleons, and 0.08 to 0.15 Bev for π-mesons), and b-particles or particles with black prongs (<0.03 Bev for nucleons and <0.15 Bev for π-mesons). The overall energy interval for the N-N interactions was subdivided into 5 energy intervals, and for the π-N interactions in 4 energy subgroups. It was assumed that the energy and angular characteristics for the elastic and inelastic interactions were constant within each subgroup. The calculated results were compared with experimental results from photoemulsion experiments, and the results were in good agreement with an intracascade mechanism for the interaction. At high excitation energies, two reactions take place: $p + N \rightarrow d + k\pi$, and $p + N \rightarrow p + n + k\pi$. In reacting 25-Bev protons with platinum, an excitation energy of about 8 Mev was assumed in order to obtain agreement with the observed experimental ratio $(d/p)_{Pt} = 0.024$. The results for Al are analogous. Calculated ratios for the number of deuterons, protons, and π-mesons were $(d/p)_{Pt} = 0.03$, $(d/p)_{Al} = 0.02$, $(d/\pi^+)_{Pt} = 0.08$, and $(d/\pi^+)_{Al} = 0.05$. These results were in good agreement with the experimental values. A high relative yield of deuterons was noted. (TTT)

33838 THE ELASTIC SCATTERING OF PROTONS BY Mg^{25} AND Mg^{26} NUCLEI. A. I. Popov, P. V. Sorokin, V. E. Storizhko, and A. Ya. Taranov (Inst. of Technical Physics, Academy of Sciences, Ukrainian SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 1074-9(Aug. 1962). (In Russian)

Targets of Mg^{25} and Mg^{26} were prepared on an electromagnetic separator by impinging magnesium ions on a beryllium foil 100 to 250 μ thick. A proton beam from an electrostatic accelerator, which was analyzed by a 90° magnetic analyzer, struck the target at an angle of 60°. The reaction products were analyzed by a magnetic spectrometer having a radius of 320 mm. The incident proton flux was measured with a Faraday cage. The elastic scattering cross sections of protons on Mg^{25} and Mg^{26} are given as a function of proton energy at angles of 90, 125, and 141° in the center-of-mass system. A total of 58 resonances, associated with Al^{26} levels, were detected for Mg^{25} in the energy interval of 1500 to 3700 kev, which corresponds to an excitation energy of 7800 to 9800 kev in Al^{26}. A total of 37 resonances are listed for Al^{27} levels. Spin and parity values were assigned to certain levels on the basis of a qualitative phase analysis of a number of the most prominent resonances. (TTT)

33839 A STUDY OF THE (n,p) AND (n,np) REACTIONS WITH THE HEAVY NICKEL ISOTOPES. A. K. Val'ter, V. Yu. Gonchar, I. I. Zalyubovskii, G. D. Latyshev, and G. P. Chursin (Gor'kii Kharkov State Univ. and Inst. of Nuclear Physics, Kazakstan Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 1079-84(Aug. 1962). (In Russian)

Fast neutrons (14.1 Mev) were produced by a $T(d,n)He^3$ reaction on irradiating a tritium–zirconium target with 100 kev deuterons. A recoil proton telescope with a polyethylene radiator (0.2 mm thick and 2 cm in diameter) and a thin CsI(Tl) crystal (1 mm thick and 1.5 cm in diameter) served as a neutron monitor. The induced β activity and half life were measured on a multichannel scintillation counter with a thin CsI(Tl) crystal. The $Al^{27}(n,p)Mg^{27}$, $Al^{27}(n,\alpha)Na^{24}$, and $Ag^{107}(n,2n)Ag^{106}$ reactions were used to calibrate the equipment. The cross sections in millibarns were found to be 86 for the $Ni^{61}(n,p)Co^{61}$ reaction, 22 for the $Ni^{62}(n,p)Co^{62}$ reaction, 34 for the $Ni^{62}(n,p)Co^{62*}$ reaction, 5 for the $Ni^{64}(n,p)Co^{64}$ reaction, 2 for the $Ni^{64}(n,p)Co^{64*}$ reaction, 4 for the $Ni^{62}(n,np)Co^{61}$ reaction, and 6 for the $Ni^{64}(n,np)Co^{63}$ reaction. A plot of the log of the reaction cross section versus Z/A gave a straight line for the nickel isotopes. (TTT)

33840 THE ELASTIC SCATTERING OF PROTONS BY O^{18} NUCLEI. P. V. Sorokin, A. I. Popov, V. E. Storizhko, and A. Ya. Taranov (Inst. of Technical Physics, Academy of Sciences, Ukrainian SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 1084-7(Aug. 1962). (In Russian)

One of the methods of studying the energy levels in F^{19} is by the reaction of protons with O^{18} nuclei. An O^{18} target was prepared on a magnetic separator by hitting a purified beryllium foil 150 μ thick with oxygen ions. The deuterons and α particles from the $Be^9(p,d)Be^8$ and $Be^9(p,\alpha)Li^6$ reactions were not counted with proper selection of the discriminator. With an average current of ~0.4 μA on the target, the yield from the target did not drop off noticeably during the experiment. The reaction products were analyzed by a magnetic spectrometer. The primary proton beam was measured on a Faraday cage. The charged particles were counted on a thin CsI(Tl) crystal. The differential elastic scattering cross section was measured at angles of 90, 125, and 141° in the center-of-mass system for energies of the incident proton from 1.7 to 3.5 Mev. The position of the resonances, the energies of the levels in F^{19}, and the level widths are presented. Thirteen

of the most prominent resonances were subjected to a phase analysis for proton energies of 1.7 and 3.2 Mev. The parity of a level was determined by comparing the theoretical form of a resonance with the experimental form. Spin and parity values are assigned to various levels. (TTT)

33841 REDUCED WIDTHS IN DISRUPTION REACTIONS WITH NON-AXIAL NUCLEI. V. K. Luk'yanov (Theoretical Physics Section, United Inst. of Nuclear Studies, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 1096-7(Aug. 1962). (In Russian)

The rotation of a non-axial nucleus leads to changes in the reduced width for a nuclear reaction, whose amplitude can be described by a Born approximation with distorted wave functions. The S-factor, which characterizes the contribution of the rotational states of the non-axial nucleus to the reduced widths, was calculated by representing the wave functions in the form of a derivative of the rotational function and a function of the external particle, and by converting the neutron function to the laboratory system of coordinates. A comparison with experiment can readily be carried out for the ratios of the reduced widths, since in this case the single-particle widths γ_0^2 drop out, and only the contribution of the collective effects (the S-factor) remains. Since the $Mg^{24}(t,d)Mg^{25}$ reaction had been studied experimentally, the relative reduced widths of the rotational states of Mg^{24} were calculated. The Mg^{24} nucleus is observed in 0^+, 2^+, 4^+, and 2^+ states, and the ratio of the energy states fits the scheme of the rotational states of a non-axial nucleus with $\gamma = 22°$. The calculated results agree with the experimental values satisfactorily. (TTT)

33842 DETERMINING THE PARAMETERS OF THE REPULSIVE POTENTIAL DUE TO THE CORE OF THE NUCLEON IN INTERNUCLEAR INTERACTIONS. B. B. Dotsenko and V. M. Salasyuk (Physics Inst., Academy of Sciences, Ukrainian SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 1097-1101(Aug. 1962). (In Russian)

It was assumed that the repulsive potential of a nucleus is not that of a solid sphere, but is a smooth function, which decreases rapidly with distance from the nucleus, and is infinite only at zero distance. The non-local potential of N. N. Bogolyubov was considered: $(r \mid V \mid r') = -a_1 u(r) + a_2 f(r) f(r')$. The first term describes the attraction, and the second term the repulsion between two nucleons. If $u(r) = \exp(-\mu r)/r$ and $f(r) = \exp(-\nu r)/r$, the repulsive part of the potential falls off rapidly with increasing distance. On solving the Schroedinger equation with a non-local potential, an expression was obtained for the scattering amplitude. Then, an expression was derived for the effective radius as a function of a number of parameters. The non-local potential was also used to solve the problem of three nucleons and to consider the effect of paired correlations in nucleons. (TTT)

33843 THE COLLECTIVE INTERACTION OF NEUTRONS WITH SPHERICAL NUCLEI. A. M. Korolev (Physics Inst., Academy of Sciences, Ukrainian SSR). Izv. Akad. Nauk SSSR. Ser. Fiz., 26: 1101-12(Aug. 1962). (In Russian)

The collective interaction of neutrons with the surface of a spherical nucleus was considered on the basis of a generalized model of the nucleus. It was assumed that the interaction can excite surface oscillations of the nucleus. The actual and imaginary parts of the optical potential of the neutron were calculated by using the method of Feshbach [Ann. of Phys., 5: 357(1958)]. It was easy to introduce another model of the nucleus into Feshbach's formulation of the nucleus. It was also shown that quasi-stationary, intermediate states can exist during excitation of the first collective level. Inelastic scattering of neutrons on spherical nuclei which are close to the magic numbers were also considered with the energy of the incident neutron close to an isolated, collective resonance. In particular, the possibility for the formation of a compound nucleus was taken into account, but direct interaction of a neutron with the nucleus was not considered. (TTT)

33844 MEASUREMENT BY CYCLOTRON RESONANCE OF MOLECULAR CROSS SECTIONS FOR ELASTIC COLLISIONS WITH 295°K ELECTRONS. K. D. Bayes, D. Kivelson, and S. C. Wong (Univ. of California, Los Angeles). J. Chem. Phys., 37: 1217-25(Sept. 15, 1962).

Cyclotron resonance absorption is used to obtain molecular scattering cross sections for electrons at 295°K. The electrons were present in active nitrogen obtained by passing N_2 through a microwave discharge, and various gases were introduced into the active nitrogen downstream from the discharge. Very weak r-f fields, with electric components parallel to the d-c magnetic field, were used in order not to "heat up" the electrons. The observed width of the cyclotron resonance line is proportional to the molecular-electronic cross section since electron-electron collisions are not significant in these experiments. But suitable averages over electron velocities must be carried out to account for the observed line shapes and to relate the line widths to the cross sections. The spectral lines are sometimes quite asymmetric and this asymmetry can then be used as a rather sensitive measure of electron concentration. Dipolar gases were observed to have large cross sections which exhibited approximately a $\frac{3}{2}$ power dependence on the dipole moment; theoretical calculations based on a partial wave treatment of dipole scatterers agreed well with experiments. The cross section for N_2 is 4.96 $Å^2$; for CO_2 302 $Å^2$; and for the dipolar gases N_2O, NH_3, SO_2, HCF_3, H_2O, HCN, and CH_3NO_2, the cross sections are 56, 1560, 1840, 1760, 2360, 5280, and 6020 $Å^2$, respectively. The dipolar cross sections are inversely proportional to the energy of the electrons, and both theoretical and experimental values of the cross sections refer to energies of 3k(295°)/2. The large cross section for CO_2 probably arises from its large quadrupole moment. (auth)

33845 ISOMERIC CROSS SECTION RATIOS IN ALPHA-PARTICLE REACTIONS. Shiro Iwata (Kyoto Univ.). J. Phys. Soc. Japan, 17: 1323-33(Sept. 1962). (In English)

Isomeric cross section ratios for reactions $Mn^{55}(\alpha,n)Co^{58}$, $Fe^{56}(\alpha,pn)Co^{58}$, and $Rb^{85}(\alpha,2n)Y^{87}$ proceeding to the metastable and ground state of the residual nucleus are measured by the activation method using a stacked-foil technique. The experimental energy dependence of σ_m/σ_g for the $Mn^{55}(\alpha,n)Co^{58}$ reaction is compared with a calculation using a square-well potential with an interaction radius of $r_0 = 1.7$ fermi and an energy-level-density of $a = 2$ Mev^{-1} in the Fermi gas model. From the comparison, it seems that setting the spin level-density parameter either to a constant value between $\sigma = 3$ to 4 or to a value dependent on nuclear temperature corresponding to $2\sigma^2 = 14.4T$ fits comparably well to the experimental results. However, the experimental result on this reaction shows that σ_m/σ_g reaches a maximum value at about 25 Mev and then decreases. This behavior may be interpreted by a mechanism of direct interaction. The energy dependence of σ_m/σ_g for the $Fe^{56}(\alpha,pn)Co^{59}$ reaction qualitatively indicates that the reaction takes place via the compound nucleus formation process, contrary to the measured results for the $Co^{59}(p,pn)Co^{58}$ reaction. (auth)

33846 NUCLEAR OPTICAL MODEL ANALYSIS OF NEUTRON ELASTIC SCATTERING FOR CALCIUM. Randall S. Caswell. J. Research Natl. Bur. Standards, 66A: 389-400(Sept.-Oct. 1962).

A nuclear optical model calculation of neutron elastic scattering using five parameters was made. Appropriate estimates of the effect of compound elastic scattering at low energies are included. Comparisons were made with experimental data, and results for the parameters adopted are given for elastic scattering in the energy range from 0.734 to 18 Mev. Although reasonably good agreement between the calculation and experimental results were obtained, there is a discrepancy between experiments below 2 Mev, and experimental data are needed between 6 and 14 Mev. Both angular distributions and Legendre expansion coefficients for the total elastic scattering are given. (auth)

33847 INDUCED RADIOACTIVITY IN IRON BY HIGH ENERGY PROTONS. I. Lin and Toshiyuki Toyoda (Rikkyo Univ., Tokyo). Japan J. Appl. Phys., 1: 41-50(July 1962). (In English)

It is important to take into account radioactivity which is induced in various materials for construction of high-intensity proton accelerators. Theoretical estimates of radiation doses are made which seem to be useful for designing high-intensity machines, for example, a 12 Bev 1 to 30 μA proton synchrotron. Since experimental data concerning spallation cross sections are scarcely known, it is necessary to extrapolate them. The Monte Carlo calculation was applied to cascade effects for several reasons. Although a high-intensity accelerator such as the 12 Bev 1 μA proton synchrotron, has not yet been built, some discussion might be possible in comparison with recent observations on induced radioactivity in iron at the CERN Proton-Synchrotron and Synchro-Cyclotron. (auth)

33848 SCHOOLING IN NUCLEAR ENGINEERING. VIII. MASS DEFECT AND ENERGY TRANSFER IN NUCLEAR REACTIONS. A. Kraut. Kerntechnik, 4: 419-20: 22(Sept. 1962). (In German)

The meaning of energy transfer is discussed. Conservation of mass in nuclear reactions is compared with that in chemical reactions. Calculation of nascent energy from mass defect is discussed. The forms in which the nascent energy may appear are discussed. Equations are given for calculating the reaction energy and nascent energy, and calculations are given for the reaction $Li^7 + H \rightarrow 2\ He^4$. Endothermal nuclear reactions are considered. The distribution of kinetic energy among the reaction products is discussed. Finally, the equations are applied to the chemical reaction $S + O_2 \rightarrow SO_2$, and a negligible nascent energy is found. (D.L.C.)

33849 LEVEL STRUCTURE OF ^{32}P FROM $^{31}P(d,p)^{32}P$ REACTIONS. T. Holtebekk (Univ. of Michigan, Ann Arbor). Nucl. Phys., 37: 353-76(Sept. 1962). (In English)

States up to an excitation energy of 6.8 Mev of the nucleus P^{32} are investigated by studying the angular distribution of protons in the reaction $P^{31}(d,p)P^{32}$. One state is found at 1.51 Mev. A state at 6.56 Mev is found to be a doublet with excitation energies 6.58 and 6.53 Mev. The angular distributions for 28 of the stronger levels are fitted with Butler curves, and probable l_n values are given for these levels. Relative reduced widths are given for the same levels. The results are discussed in terms of the Nilsson rotational model and the shell model. (auth)

33850 COULOMB EXCITATION OF COLLECTIVE STATES IN MEDIUM MASS NUCLEI USING 45 Mev OXYGEN IONS. D. Eccleshall, B. M. Hinds, M. J. L. Yates, and N. MacDonald (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Nucl. Phys., 37: 377-95(Sept. 1962). (In English)

The 4^+ and second 2^+ states in Pd^{108}, Cd^{112}, and Cd^{114} are excited using 45-Mev O^{16} ions. The third 2^+ state in Cd^{114} is also weakly excited. The decay of these levels is studied by detecting the γ rays emitted from thick targets either directly or in coincidence with backscattered oxygen ions. The γ yields from the decay of the 4^+ states are interpreted using second order perturbation theory of Coulomb excitation to give values of $B_{E2}(2^+ \rightarrow 4^+)/B_{E2}(0^+ \rightarrow 2^+)$. The results are very similar to those obtained experimentally for neighboring nuclei. The schemes of low-lying levels in these and neighboring nuclei are discussed in relation to various models. The model involving the rotations and vibrations of an asymmetric nucleus is considered in some detail. (auth)

33851 PHOTONUCLEAR EFFECT WITH Be^9. B. Čujec (J. Stefan Inst., Ljublijana, Yugoslavia). Nucl. Phys., 37: 396-411(Sept. 1962). (In English)

The reactions $Be^9(\gamma,n)Be^8$ and $Be^9(\gamma,p)Li^8$ are measured using bremsstrahlung of 32 Mev and nuclear emulsions containing Be^9. The cross sections involving different excited states of Be^8 and the ground and first-excited states of Li^8 are compared with theory assuming LS-coupling for Be^9 and direct emission of the excited nucleon. Agreement between theory and experiment is found. Some evidence is presented that the 16.0-Mev level of Be^8 is a $^3P(31)$ level with $J = 2^+$ and that the 16.7- and 17.6-Mev levels are respectively 2^+ and 0^+ levels of multiplet $^3P(31)$. The $Be^9(\gamma,d)Li^7$ and $Be^9(\gamma,t)Li^6$ reactions are also observed. Their estimated cross sections are about half of that of the $Be^9(\gamma,p)Li^8 \rightarrow Be^8$ reaction or about 8% of the total photonuclear absorption cross section between 16 and 32 Mev. (auth)

33852 SCATTERING OF 14 Mev NEUTRONS ON BORON, CARBON, AND SULFUR. K. Tesch (Technische Hochschule, Aachen). Nucl. Phys., 37: 412-24(Sept. 1962). (In German)

The angular distributions from the elastic and inelastic scattering of 14-Mev neutrons on B, C, and S are studied using an associated-particle time-of-flight technique. For each element the differential cross sections for inelastic scattering are measured for neutrons scattered from the first excited state and for two neutron groups with energies corresponding to excitation energies of 3.5 to 6 Mev and 6 to 8 Mev. From the angular distributions it follows that the inelastic scattering from the first excited state proceeds via direct interaction, whereas the scattering from higher levels may be influenced by compound nucleus formation. The cross sections for first-level scattering are compared with theoretical calculations. Optical model calculations are quoted for comparison with the measured elastic scattering cross sections. (auth)

33853 ISOMERIC (γ,n) CROSS SECTION RATIOS AND THE SPIN DEPENDENCE OF THE NUCLEAR LEVEL DENSITY. J. H. Carver, G. E. Coote, and T. R. Sherwood (Australian National Univ., Canberra). Nucl. Phys., 37: 449-56(Sept. 1962). (In English)

Isomeric (γ,n) cross section ratios are measured for 11 nuclei with $59 \leq A \leq 198$. The nuclei are excited by gamma rays in the giant resonance region and residual (γ,n) activities are measured with a NaI(Tl) scintillation spectrometer. The isomeric ratios are analyzed using statistical calculations, and estimates are obtained of the parameter σ, which characterizes the spin dependence of the nuclear level density. Other estimates of σ are summarized and it is found that for light nuclei ($A \lesssim 50$), $\sigma \approx \sigma_0$ (the value calculated from statistical theory with corrections for shell effects). For heavy nuclei ($A \gtrsim 100$) σ falls to approximately $0.6\ \sigma_0$. (auth)

33854 PROPERTIES OF Fe^{57} AND THE PROTON-NEUTRON INTERACTION. Ikuko Hamamoto and Akito Arima (Tokyo Univ.). Nucl. Phys., 37: 457-68(Sept. 1962). (In English)

The ground state of Fe^{57} has an anomalous spin of $\frac{1}{2}$ and a very small magnetic moment, which cannot be explained in the conventional shell model. A shell model with a residual interaction is applied to a study of these properties. The interaction between neutrons is assumed to be a combination of a short-range force and a $P^{(2)}$-force. The strengths of these interactions are determined by a comparison between the calculated and observed spectra of Ni^{58} and Ni^{59}. A simple $P^{(2)}$-force is taken to approximate the proton-neutron interaction. It is shown that the role of this proton-neutron interaction is important in the understanding of the structure of Fe^{57}. In particular, this interaction pushes the $\frac{1}{2}$-state down to the ground state. Agreement with many of the observation data is obtained. (auth)

33855 l-FORBIDDEN M1 TRANSITIONS NEAR DEFORMATION REGION. E. Ye. Berlovich, Yu. K. Gusev, V. V. Ilyin, V. V. Nikitin, and M. K. Nikitin (Physical-Technical Inst., Academy of Science, Leningrad). Nucl. Phys., 37: 469-75(Sept. 1962). (In English)

A study is made of the half lives of M1 transitions of the type $g_{\frac{9}{2}} \rightarrow d_{\frac{5}{2}}$ in the spherical nuclei Eu^{147}, Eu^{149}, and Eu^{151}, which are situated directly below the deformation region. The half lives of the first excited states ($g_{\frac{9}{2}}$) for these nuclei equal $1.8 \pm 0.2 \times 10^{-10}$, $3.2 \pm 0.2 \times 10^{-10}$, and $3.4 \pm 0.2 \times 10^{-9}$ sec respectively, and the M1 transition delay factors are 115, 78, and 47 respectively, in contrast to the mean value ≈300 for other one-proton l-forbidden M1 transitions. The observed small values of the delay factors and their monotonic decrease when approaching the deformation region are seen to reflect the growing contribution of collective motion and hence the attenuation of l-forbiddenness. (auth)

33856 SEARCH FOR A $\frac{9}{2}$+ LEVEL AT 1.5 Mev IN Y^{89}. D. A. Howe, L. M. Langer, and D. Wortman (Indiana Univ., Bloomington). Nucl. Phys., 37: 476-81(Sept. 1962). (In English)

A search is made for a $\frac{9}{2}$+ level at 1.5 Mev in Y^{89} by examining radiations from Zr^{89}. The intensity of transitions feeding such a level is established as less than 0.008% of the total transitions. The comparative half life for the decay of Zr^{89} to this level corresponds to log ft > 9.7. (auth)

33857 LIFETIME OF THE FIRST 2^+ LEVEL IN Cm^{244}. Per Rex Christensen (Univ. of Copenhagen). Nucl. Phys., 37: 482-5(Sept. 1962). (In English)

The half life of the 42.9-kev 2^+ level in Cm^{244} is measured using the delayed coincidence method. An exponential decay is directly observed in the time spectra. The result obtained is $T_{\frac{1}{2}} = (0.97 \pm 0.05) \times 10^{-10}$ sec. (auth)

33858 ON THE SHAPE OF THE GIANT RESONANCE IN DEFORMED NUCLEI. S. F. Semenko (Lebedev Inst. of Physics, Moscow). Nucl. Phys., 37: 486-94(Sept. 1962). (In English)

The effect of the residual interaction and of the form of the one-particle potential on the shape of the giant resonance in strongly deformed nuclei is discussed. It is shown that taking the residual interaction into account does not change either the predictions of the simple one-particle model for the splitting of the giant resonance into two maxima, or estimates made on the basis of the one-particle model of the ratio of the dispersions of the energies around these maxima. (auth)

33859 PHOTOPROTONS FROM HEAVY NUCLEI. V. G. Shevchenko and B. A. Yuryev (Moscow State Univ.). Nucl. Phys., 37: 495-505(Sept. 1962). (In English)

The angular and energy distributions were investigated and the photoproton yields measured from Rh, Pr, W, Pt, and Pb for maximum bremsstrahlung energies of 22.5 and 33.5 Mev. The maxima of the cross sections for the production of photoprotons were found to be energies above 22 Mev, and the absorption of γ quanta in this energy region by these nuclei was found to have chiefly a quadrupole character. The contribution of the quadrupole absorption increased with Z. (auth)

33860 INTERPRETATION OF GROUPS OBSERVED IN THE NEUTRON SPECTRA OF DIRECT (p,n) REACTIONS. A. M. Lane and J. M. Soper (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucl. Phys., 37: 506-16(Sept. 1962). (In English)

Observations at small angles of neutrons from (p,n) reactions at 15 Mev show the occurrence of a systematic narrow group, which may be interpreted as isobaric-state excitation. It is pointed out that a broader group caused by excitation of states of the same configuration as that of the target, i.e. to "isobaric configuration selection," should be expected. Estimates are made of the width and position of this group. There is some evidence for its occurrence from (p,n) results at 150 Mev. (auth)

33861 RE-ALIGNMENT AS A POSSIBLE AFTER-EFFECT OF K-HOLE FORMATION. Hans A. Weidenmueller (California Inst. of Tech., Pasadena). Nucl. Phys., 37: 517-21(Sept. 1962). (In English)

In measurements of the distribution of gamma rays following the K-capture by aligned nuclei, it is usually assumed that the influence of the K-hole tends to make the observed angular distribution more isotropic (i.e., to cause de-alignment). It is shown that as a result of the correlation between the direction of the spin of the K-hole and the nuclear spin after K-capture, the opposite possibility exists, viz. a realignment is possible. The effect is discussed quantitatively for the Co^{58} nucleus as an example. (auth)

33862 IDENTIFICATION OF A SPIN 5 STATE IN Cr^{52}. Morton Kaplan and D. A. Shirley (Univ. of California, Berkeley). Nucl. Phys., 37: 522-5(Sept. 1962). (UCRL-10207). (In English)

The state at 3.614 Mev in Cr^{52} is found to have a spin of 5 by low temperature nuclear orientation techniques. It is thus reasonable to identify this state with the spin 5 seniority-four state predicted for an $(f_{\frac{7}{2}})^4$ configuration. The angular distribution parameters for the 1.246-Mev γ ray, connecting this state with the 4+ state at 2.369 Mev, require that the amplitude mixing ratio δ(E2/M1) be negative. It is probable that this transition is 3 to 23% quadrupole. (auth)

33863 TWO METHODS OF DERIVING THE EQUILIBRIUM SHAPES OF A LIQUID DROP NUCLEUS. S. Gallone and G. Ghilardotti (AGIP Nucleare, San Donato Milanese, Milan). Nuovo cimento (10), 25: 817-37(Aug. 16, 1962). (In English)

Two independent sets of equilibrium conditions for the liquid drop nucleus are derived. The first set is obtained by evaluating the potential energy of the liquid drop as a function of suitable deformation parameters, starting from a reference ellipsoid and then finding the conditions for this quantity to be stationary. The second set is obtained by requiring that the "hydrostatic pressure" be constant on the surface of the equilibrium shape. The equilibrium equations obtained by the two approaches are compared, and found to be equivalent up to the order of approximation considered, although not algebraically coincident. An auxiliary condition is derived, in order that the reference ellipsoid be as close as possible to the equilibrium deformed shape. A discussion of the equilibrium equations is given, and the

results tested on the similar problem of the determination of planetary shapes. (auth)

33864 ON THE PHOTONUCLEONS' POLARIZATION. A. Molinari and G. Ponzano (Università, Turin and Istituto Nazionale di Fisica Nucleare, Turin). Nuovo cimento (10), 25: 846-56(Aug. 16, 1962). (In English)

The polarization of the nucleons emitted by photodisintegration of odd, complex nuclei is calculated by the use of a model with independent particles. General formulae are deduced, which hold for photons and polarized nuclei; from consideration of these formulae, the correlation between spin and angular momentum in the bound state is found to contribute effectively to the nucleon's polarization. The particular case of C^{13} is considered; the results obtained using various phase-shift systems show that the polarization depends strongly on them. (tr-auth)

33865 EXPERIMENTAL RESULTS ON THE NUCLEAR FISSION PRODUCED BY 600 Mev PROTONS. H. G. de Carvalho (Università, Naples and Istituto Nazionale di Fisica Nucleare, Naples), G. Potenza, R. Rinzivillo, E. Sassi, and G. Vanderhaeghe. Nuovo cimento (10), 25: 880-9(Aug. 16, 1962). (In English)

The fission phenomena produced by protons of about 600 Mev are studied in a number of nuclei U^{238}, Th^{232}, Bi^{209}, W^{184}, and natural Ag, by means of loaded, low-sensitivity nuclear emulsions. The relative cross sections are tabulated. For U and Th the angular distribution is studied, with particular regard given to "noncollinear" tracks. No sign of anisotropy is found. For noncollinear events, a possible correlation is sought between the angle formed by the two tracks and the angle between the line connecting the two track extremities and the direction of the incident beam. No correlation is found. (auth)

33866 DECAY SCHEME OF ^{211}Pb. M. Gianini, D. Prosperi, and S. Sciuti (Centro di Studi Nucleari della Casaccia, Rome and Università, Rome). Nuovo Cimento (10), 25: 1227-38(Sept. 16, 1962). (In English)

Some experimental results concerning $Pb^{211} \rightarrow Bi^{211}$ decay are reported. Coincidence spectra and γ-γ angular correlations are used to measure the transition intensities and to assign spins. Levels at 1100 and 1020 kev are found. A decay scheme is proposed. (auth)

33867 INTENSITY MEASUREMENTS OF ALPHA GROUPS FROM ^{211}Bi, ^{211}Po, ^{219}Rn and ^{223}Ra BY MEANS OF SOLID STATE COUNTER TECHNIQUES. M. Giannini, D. Prosperi, and S. Sciuti (Centro de Studi Nucleari della Casaccia, Rome and Università, Rome). Nuovo Cimento (10), 25: 1314-21(Sept. 16, 1962). (In English)

By means of solid-state counter techniques the intensity of the α groups from Bi^{211}, Po^{211}, Rn^{219}, and Ra^{223} is measured. In particular the branching $\beta/(\alpha+\beta)$ in Bi^{211} is measured as $(0.29 \pm 0.01) \times 10^{-2}$. (auth)

33868 ELECTRIC QUADRUPOLE TRANSITIONS BETWEEN SOME EXCITED STATES IN SPHERICAL EVEN-EVEN NUCLEI. G. Sartoris (Università, Naples and Istituto Nazionale di Fisica Nucleare, Naples) and J. Touchard. Nuovo Cimento (10), 25: 1375-82(Sept. 16, 1962). (In English)

The branching ratios from the higher excited states in spherical even-even nuclei are calculated using a simplified model, which includes only a single j shell, and a pairing plus quadrupole residual interaction between nucleons. The method is applied to the branching from the 4+ levels. It is found that the E2 transition to the second 2+ level can be enhanced against the corresponding one to the first 2+ level for more than one 4+ level. (auth)

33869 ON THE TWO-CENTER MODEL AND THE NONLOCAL THEORY OF HIGH-ENERGY INTERACTIONS. G. Wataghin (Università, Turin). Nuovo Cimento (10), 25: 1383-8(Sept. 16, 1962). (In English)

Starting from experimental data on high-energy jets, a nonlocal theory of the 2-center model of jets is proposed. Many features observed experimentally in jets are deduced from this theory. A formulation for cut-off rules is suggested. (auth)

33870 EFFECTS OF PAIRING AND QUADRUPOLE FORCES ON THE BRANCHING RATIOS FROM THE HIGHER EXCITED STATES IN SPHERICAL EVEN-EVEN NUCLEI. R. A. Ricci (Università, Naples and Istituto Nazionale di Fisica Nucleare, Naples), M. Jean, and R. van Lieshout. Nuovo Cimento (10), 25: 1389-92 (Sept. 16, 1962). (In English)

A model is considered in which an even number of nucleons of the same kind are confined to a single j shell, and in which the residual interaction force is assumed to consist of a "pairing" force plus a long-range "quadrupole" force. This residual interaction is considered in terms of the quasi-particle and random-phase approximations. The model is shown to afford a qualitative interpretation of gamma transition probabilities to the lower 2+ and 4+ excited states of even-even spherical nuclei. (T.F.H.)

33871 LIFETIME DETERMINATION OF THREE EXCITED LEVELS IN THE ODD-ODD NUCLEUS Pr^{144}. J. Burde, M. Rakavy, and G. Engler (Hebrew Univ., Jerusalem). Phys. Letters, 1: 147-9(June 1, 1962).

The lifetimes of the 133.5-, 100-, and 80.1-kev energy levels in Pr^{144}, as well as the gamma transition probabilities for decay of these levels to lower excited states and to the ground state, are measured. The transition probabilities for a total of six lines are measured. The transition probabilities for three lines de-exciting the 133.5-kev level are compared with shell-model predictions. (T.F.H.)

33872 VIBRATIONS OF SPHERICAL NUCLEI. A. K. Kerman (Université, Paris) and C. M. Shakin. Phys. Letters, 1: 151-3(June 1, 1962).

A second-order perturbation calculation of the low and intermediate energy levels of spherical nuclei is presented. The Hamiltonian for the nucleus is expanded in powers of terms that are, in a sense, proportional to the quadrupole tensor, and of terms that are proportional to the first time derivatives of these quadrupole-tensor terms. The results are compared with the observed levels of Ni^{62} between 1.17 and 2.89 Mev. (T.F.H.)

33873 DERIVATION OF ANHARMONICITY OF NUCLEAR QUADRUPOLE OSCILLATION FROM THE EXTENDED SAWADA METHOD. Dipti Mitra (Clarendon Lab., Oxford) and M. K. Pal. Phys. Letters, 1: 153-5(June 1, 1962).

It is shown that an anharmonic addition to the nuclear vibrational Hamiltonian for even-even nuclei can be obtained by an approach based on the nonlinear extension of the Sawada method for treating collective oscillations. The resultant corrected Hamiltonian is found to give results that agree with experimental data, in the case of transition rates and two-phonon-level splitting in the quadrupole vibrational levels of even-even nuclei. (T.F.H.)

33874 DIFFUSENESS OF THE NUCLEAR SURFACE. P. W. Anderson (Cambridge Univ., Eng.) and D. J. Thouless. Phys. Letters, 1: 155-7(June 1, 1962).

A liquid-drop nucleus is considered. For this nucleus, the effects of surface oscillations on the diffuseness of the nuclear surface are calculated. It is estimated on the basis

of the zero-point motion of these oscillations that the density falls from 0.9 to 0.1 times its maximum value in about 2.0×10^{-13} cm, and that this distance is independent of the nuclear size. The calculated distance is compared with the distance observed experimentally for several spherical nuclei, viz. $(2.4 \pm 0.3) \times 10^{-13}$ cm. (T.F.H.)

33875 RESONANCES IN THE α-INDUCED FISSION OF NEON 20. N. O. Lassen (Univ. of Copenhagen). Phys. Letters, 1: 161-2(June 1, 1962).

The excitation curve for the reaction $Ne^{20}(\alpha,C^{12})C^{12}$ is measured, and the angular distributions of carbon ions are determined, for incident α energies of 12 to 17 Mev. (T.F.H.)

33876 THE DIPOLE STATE IN C^{13}. B. R. Easlea (Univ. of Copenhagen). Phys. Letters, 1: 163-6(June 1, 1962).

The change in the dipole state of C^{12} produced by the addition of a single neutron is calculated. The C^{12} nucleus is considered as a closed-shell nucleus in the j-j coupling model, and C^{13} is considered as the addition of a $1p_{1/2}$ valence neutron to this C^{12} nucleus. The calculations include a zero-range force, do not include ground-state correlations, and do not have self-consistently chosen single-particle states. The calculations correctly predict the observed structure of the giant resonance, viz. a splitting of the resonance into a $T = 1/2$ and a $T = 3/2$ peak, and a dominance of the higher-lying $T = 3/2$ states over the $T = 1/2$ states. (T.F.H.)

33877 QUASI-FREE PROTON–PROTON SCATTERING IN Li^6 AND Li^7. G. Tibell, O. Sundberg, and U. Miklavžič (Univ. of Uppsala). Phys. Letters, 1: 172-4(June 1, 1962).

Angular distributions and summed energy spectra are presented for (p,2p) reactions on Li^6 and Li^7 at 185 Mev. The data are used to calculate the binding energies of the s and p proton groups in these nuclei. (T.F.H.)

33878 SCATTERING OF μ MESONS BY CARBON. A. Citron, C. Delorme, D. Fries, L. Goldzahl, J. Heintze, E. G. Michaelis, C. Richard, and H. Oeverås (CERN, Geneva). Phys. Letters, 1: 175-8(June 1, 1962).

The scattering of 180- and 240-Mev/c μ^- mesons by C is measured at angles up to 72.5°. Four-momentum transfers up to 250 Mev/c ($|q|^2 = 1.5$ fermi^{-2}) are thus achieved. Within the limits of experimental error, no deviation (other than that arising from the mass difference) is found between the μ^- and electron scattering cross sections on C. Further, if it is assumed that the μ^- meson has a structure with an rms charge radius r_0, an upper limit of $r_0 = 0.68$ fermi can be set with 95% confidence. (T.F.H.)

33879 (d,t) REACTION ON THE TITANIUM ISOTOPES. J. L. Yntema (Argonne National Lab., Ill.). Phys. Rev., 127: 1659-63(Sept. 1, 1962).

The (d,t) reaction on the five stable isotopes of titanium is studied at a deuteron energy of 21.4 Mev. The three even isotopes show two strong groups separated by about 2 Mev, both groups corresponding to pickup of a $1f_{7/2}$ neutron. This indicates that there is considerable seniority mixing in the titanium isotopes. Groups corresponding to the pickup of 2p neutrons are observed in both Ti^{50} and Ti^{48}. In the reaction on Ti^{48}, an $l = 2$ transition to a state near 1.8 Mev in Ti^{47} was found. The odd-even isotopes show a number of strong groups. The ground-state transitions in $Ti^{46}(d,t)Ti^{47}$ and $Ti^{47}(d,t)Ti^{46}$ are not observed. (auth)

33880 EFFECT OF HARD CORE ON THE PHOTO-DISINTEGRATION CROSS SECTIONS OF H^3. V. S. Mathur, S. N. Mukherjee, and M. L. Rustgi (Banaras Hindu Univ., Varanasi, India). Phys. Rev., 127: 1663-5(Sept. 1, 1962).

The electric-dipole bremsstrahlung weighted cross section (σ_b) and the integrated cross section (σ_{int}) for the photodisintegration of H^3 are calculated using hard-core wave functions. A comparison with already published calculations indicates that the introduction of the hard core increases σ_b and σ_{int} for the H^3 nucleus by about 100 and 8% respectively. (auth)

33881 STUDY OF THE $Sm^{149}(n,\alpha)Nd^{146}$ REACTION WITH THERMAL NEUTRONS. Ronald D. MacFarlane (Univ. of California, Berkeley) and Ismael Almodovar. Phys. Rev., 127: 1665-9(Sept. 1, 1962). (UCRL-10064)

The cross section for the $Sm^{149}(n,\alpha)Nd^{146}$ reaction at thermal neutron energies is measured by observing the alpha spectrum of natural Sm and isotopically enriched Sm^{149} targets in the thermal column of a reactor. Alpha groups are observed at 8.72 and 9.12 Mev, corresponding to transitions to the first-excited and ground states of Nd^{146}. The thermal cross sections (σ_0) for the two groups are calculated to be 121 ± 15 and 22 ± 10 mb respectively from the experimental results. The 4− resonance at 0.0967 ev accounts for most of the cross section to the first excited state, but cannot contribute to the population of the ground state. It is postulated that the population of the ground state arises from a contribution of a bound 3− state in Sm^{150}. Calculated values for the (n,α) cross section are compared with the experimental results. (auth)

33882 PAIRING ENERGIES OF HEAVY NUCLEI. R. C. Barrett (Clarendon Lab., Oxford). Phys. Rev., 127: 1670-1(Sept. 1, 1962).

An investigation is made into the small-scale fitting of the nuclear mass surface by means of a semi-empirical mass formula. This formula is then used in the determination of pairing energies. (auth)

33883 NUCLEAR SINGLE-PARTICLE WAVE FUNCTIONS. K. R. Greider (Univ. of California, San Diego, La Jolla, Calif.). Phys. Rev., 127: 1672-7(Sept. 1, 1962).

An approximate single-particle nuclear wave function is derived by solving an appropriate single-particle Schrödinger equation in a Hartree approximation with two-body central forces. The result of the first iteration is obtained in analytic form by means of the Thomas approximation in analogy with the Hulthén deuteron function. Because the wave function exhibits the experimentally correct asymptotic form for large particle separation, while maintaining the expected smooth behavior at small separations, it yields a high degree of accuracy of the normalization. Comparison is made with the single-particle momentum distribution of He^4 obtained from (p,d) pickup experiments, and applications to the analysis of various inelastic scattering processes are discussed. (auth)

33884 SPIN-ORBIT SPLITTINGS IN NUCLEAR SHELL MODEL. B. L. Cohen, P. Mukherjee, R. H. Fulmer, and A. L. McCarthy (Univ. of Pittsburgh). Phys. Rev., 127: 1678-80(Sept. 1, 1962).

Data (mostly from "stripping reactions") on locations of nuclear shell-model states are analyzed to determine energy splittings of spin-orbit doublets, and the systematics is studied. The expected $(2l + 1)$ dependence of the splitting is roughly corroborated, but the splitting is considerably larger than is expected when the two levels are in different major shells. The mass dependence of the splitting is somewhat stronger than the expected proportionality to $A^{-2/3}$. Applications to "reduced mass" questions, and to the location of unknown levels, are discussed. (auth)

33885 RESONANCE CAPTURE γ RAYS FROM PLATINUM. R. E. Chrien, H. H. Bolotin, and H. Palevsky (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 127: 1680-7(Sept. 1, 1962). (BNL-6056)

The high-energy gamma rays following neutron capture in a platinum target are studied using a fast chopper facility. The transitions to the 0^+ ground state and the first two excited 2^+ states in Pt^{196} are measured for 15 resonances from 11.9 to 296 ev. Relative transition probabilities for these cases are determined and compared to the chi-squared class of probability distribution functions. (auth)

33886 DIRECT OBSERVATION OF RESONANT p-WAVE NEUTRON CAPTURE. H. E. Jackson (Argonne National Lab., Ill.). Phys. Rev., 127: 1687-90(Sept. 1, 1962). (UAC-6166)

The capture γ spectra of resonances in Mo^{95} below 700 ev are studied in an effort to make unambiguous identification of individual resonances resulting from capture of p-wave neutrons. A discussion is presented of the features of the experimental spectra that can be used to identify the parity of the compound state formed by neutron capture. In part particular, a resonance in Mo^{95} at 107 ev with an anomalously strong ground-state transition is observed. The strength of this line is inconsistent with s-wave capture. The resonance is concluded to arise from capture of a p-wave neutron; to be an E1 transition; and to have a capture state of 1^-. (auth)

33887 A NEW ISOTOPE, Pt^{201}. J. Facetti, E. Trabal, R. McClin, and S. Torres (Puerto Rico Nuclear Center, Mayagüez). Phys. Rev., 127: 1690-2(Sept. 1, 1962).

A Pt isotope is found by irradiation of mercury compounds with neutrons. The Pt activities are separated from the mixture by precipitations as K_2PtCl_6. In this fraction, a 2.3 ± 0.2 min activity is observed and attributed to Pt^{201}, produced by $Hg^{204}(n,\alpha)Pt^{201}$. The Pt^{201} decays to Au^{201}. The genetic relationship is established by chemical separations of the daughter nuclide. The Au^{201} is identified by its half life and gamma energy. Further, the growth of the gamma ray of 0.55 Mev, corresponding to Au^{201}, is measured in the isolated Pt fraction with a 4-in. × 4-in. NaI(Tl) scintillator coupled to a 512-channel pulse-height analyzer. (auth)

33888 NUCLEAR EXCITATION FUNCTIONS AND THICK-TARGET YIELDS F^{19}, Na^{23}, $As^{75}(d,t)$, AND Na^{23}, $As^{75}(d,p)$. Lawrence H. Bowen and John W. Irvine, Jr. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 127: 1698-1703(Sept. 1, 1962).

Excitation functions and thick-target yields are determined for (d,p) and (d,t) reactions that occur when sodium fluoride and arsenic targets are bombarded with deuterons of ≈15 Mev. The yields of F^{18}, Na^{24}, and Na^{22} from sodium fluoride targets and As^{76} and As^{74} from arsenic targets are measured with a calibrated scintillation counter after appropriate chemical treatment. The range-energy relationship for deuterons in sodium fluoride is determined experimentally from 15.2 to 5.3 Mev. Absolute cross sections are determined at 15.2 Mev for the following reactions: $Na^{23}(d,p)Na^{24}$ (125.7 ± 2.5 mb); $Na^{23}(d,t)Na^{22}$ (12.2 ± 2.0 mb); $F^{19}(d,t)F^{18}$ (29.0 ± 2.2 mb); $As^{75}(d,p)As^{76}$ (140.3 ± 6.6 mb); and $As^{75}(d,t)As^{74}$ (16.5 ± 1.2 mb). The results are shown to be in qualitative agreement with information on the relative contributions of compound nucleus formation and direct interaction. (auth)

33889 RADIOACTIVE DECAY OF Tb^{157} AND Tb^{158}. M. R. Bhat and M. L. Pool (Ohio State Univ., Columbus). Phys. Rev., 127: 1704-8(Sept. 1, 1962).

Dysprosium, enriched to 13.8% in Dy^{156} and to 0.9% in Dy^{158}, is irradiated with neutrons, and a terbium chemical fraction is obtained. The mass number of 158 is assigned to the gamma activity in the chemical fraction. The assignment is confirmed by a comparison of the scintillation spectrum of the terbium chemical fraction with that obtained from gadolinium enriched in Gd^{157} and Gd^{158} respectively, when bombarded with 6-Mev protons. Tb^{158} decays mostly by electron capture and partly by beta emission. In the electron capture decay of Tb^{158}, gamma rays of energy 79.7, 182.7, 770, and 950 kev are emitted. A 99.3-kev gamma ray is emitted in the beta decay of Tb^{158}. Coincidence studies are carried out and the relative intensities of the gamma rays are determined. A decay scheme consistent with the data obtained is given. The enriched samples of gadolinium bombarded with protons do not show any gamma rays that can be associated with a long-lived activity of Tb^{157}. Experimental results indicate a long-lived activity of Tb^{157} that decays by L and K capture. (auth)

33890 CHARACTERIZATION OF Ru^{107}, Ru^{108}, Rh^{107}, AND Rh^{108}. William R. Pierson, Henry C. Griffin, and Charles D. Coryell (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 127: 1708-22(Sept. 1, 1962).

The mass number of Rh^{107} (21.7 ± 0.4 min) is confirmed by alpha bombardments of Ru^{104} at selected energies, by fast-neutron bombardment of Pd^{108}, and by chemical identification; and the mass number of Rh^{108} (16.8 ± 0.5 sec) is established by the nature of its γ radiations. The mass numbers of the two precursors Ru^{107} (4.2 ± 0.3 min) and Ru^{108} (4.5 ± 0.2 min) thereby also established. The main radiations associated with these species are as follows (energies in kev): Ru^{107} β groups of 2100 ± 300 and 3150 ± 300, γ rays of 195 (14%, coincident with the 2100 β), 370 (~6%, coincident with the 195 γ), 480 (weak, seen only in coincidence with the 195 γ), 860 (7%, coincident with the 195γ), 930 (4%), 1030 (4%), and 1290 (4%); Ru^{108} β groups 1150 ± 100 and 1320 ± 100, a γ of 165 ± 3 (28%, coincident with the 1150 β); Rh^{107} β groups of 840 ± 40, 940 ± 70, 1140 ± 50, and 1200 ± 50, γ rays of 115 (0.5%), 285 (~3%, seen only in coincidence with the 390 γ), 307 (73%, coincident with the 1200 β), 365 (~2%, coincident with the 307 γ), 390 (11%, coincident with the 1140 and 840 β groups), 470 (1%), 570 (2%, coincident with the 940 β), and 675 (3%, coincident with the 840 β), and γ coincidence-sum lines at 680 (~3%), 880 (very weak), and 1140 (≤0.5%); and Rh^{108} β of 4500 ± 600, γ rays of 430 (43%), 510 (10%, partly coincident with the 430 γ), 620 (22%, coincident with the 430 γ), 1520 (5%), and 2000 (≤3%). No 940-kev γ from the Pd^{108} 940-kev level is detected (<3%), and less than one-third of the 510-kev γ rays follow β transitions to the 940-kev level. All γ rays above 115-kev in the four species are in fast coincidence with β rays. There are other γ rays associated with these species, especially for Ru^{107} and/or Rh^{108} above 1500 kev. No evidence is found for isomers of Pd^{107}, Rh^{107}, Pd^{108}, or Rh^{108} from decay of 21.7-min Rh^{107} or 16.8-sec Rh^{108}. No Rh^{107} or Rh^{108} isomers can be isolated. However a γ ray of 21 kev, presumed to be a K x ray of rhodium, appears in the short-lived ruthenium spectrum, with an intensity of 5 to 8% relative to Ru^{107}; this is attributed to a short-lived (<10 sec) Rh^{107} isomer formed in >8% of the Ru^{107} disintegrations. Decay paths are proposed. Interpretations of these schemes are presented. (auth)

33891 COMPOUND NUCLEUS FORMATION MECHANISMS IN REACTION OF HEAVY IONS WITH MEDIUM-MASS ELEMENTS. Jacques B. J. Read, Inge-Maria Ladenbauer-Bellis, and Richard Wolfgang (Yale Univ., New Haven). Phys. Rev., 127: 1722-31(Sept. 1, 1962).

Excitation functions and range distributions of heavy products formed by the reaction of O^{16}, N^{14}, and C^{12} with Mn^{55} and Co^{59} are measured. Results show that the bulk of products having mass numbers greater than that of the target, are formed exclusively by decay of a compound

nucleus formed by complete fusion of target and projectile. One nuclide, Cu^{61}, can also be formed from O^{18} bombardment of Co^{55} (but not from the formally similar compound system $Mn^{55} + Ne^{20}$) by a mechanism in which only part of the momentum of the projectile is transferred. This second mechanism appears to be representative of products having mass near that of the target, which can be formed by nucleon transfer in a grazing reaction. No evidence is found for a general type of "buckshot" mechanism. Small yields of Na^{24} and P^{32} appear to result from a fission or fragmentation mechanism. (auth)

33892 EXCITATION FUNCTIONS OF (p,xp) REACTIONS. David L. Morrison and Albert A. Caretto, Jr. (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 127: 1731-8(Sept. 1, 1962).

Radiochemically measured excitation functions are reported for several (p,xp) reactions ($x \geq 2$), for target nuclei encompassing a wide range of mass numbers and for incident energies of 100 to 440 Mev. The (p,2p) reactions are studied using Si^{30}, Zn^{68}, and W^{186} as target nuclei; the (p,3p) reactions are studied using Si^{30}, P^{31}, V^{51}, As^{75}, W^{186}, and Re^{187}; the (p,4p) reactions are studied using P^{31}, S^{32}, As^{75}, and Re^{187}; and a (p,5p) excitation function is measured using S^{32} as the target. The data do not seem to exclude important contributions by either the knock-on or evaporation mechanisms in all mass regions studied, although according to qualitative arguments it seems plausible that knock-on processes predominate in the high-mass region. (auth)

33893 HYPERFINE STRUCTURE AND NUCLEAR MOMENTS OF THULIUM-166. J. C. Walker (Princeton Univ., N. J.). Phys. Rev., 127: 1739-45(Sept. 1, 1962). (PUC-1962-60)

The hyperfine structure of 7.7-hr Tm^{166} is studied using the atomic-beam magnetic resonance technique. The results are $|A| = 19 \pm 6$ Mc, $|B| = 770 \pm 300$ Mc, and $B/A < 0$. Values of the nuclear moments are calculated from the hyperfine interaction constants A and B for Tm^{166} using known values for A, B, μ_I, and Q for Tm^{170}. Results for Tm^{166} are $|\mu_I| = 0.05 \pm 0.03$ nm and $|Q| = 4.6 \pm 0.7$ b with $Q/\mu_I > 0$. These results are discussed from the standpoint of a deformed-nucleus model. (auth)

33894 ELECTRON-NUCLEAR DOUBLE RESONANCE, NUCLEAR MOMENTS, AND $\langle r^{-3} \rangle$ OF NEODYMIUM-143(III) AND NEODYMIUM-145(III) IN LANTHANUM TRICHLORIDE. Donald Halford (Univ. of Chicago). Phys. Rev., 127: 1940-8 (Sept. 15, 1962).

The electron-nuclear double resonance (ENDOR) spectra of dilute solutions of trivalent Nd^{143} and Nd^{145} ions occurring at the La^{+3} ion sites in the axially symmetric $LaCl_3$ structure are measured at the temperature of boiling He. For laboratory fields of $\approx 10^3$ G the frequencies ν_n of the ENDOR transitions are in the range $10 \leq \nu_n \leq 1000$ Mc. The experimental results for each nuclide are summarized by giving values of the parameters in the spin Hamiltonian. The frequencies are least-squares fitted with rms deviations of 0.08δ to 0.3δ, where δ is the average ENDOR line width, 3×10^5 cps. The g'_n factor in the spin Hamiltonian is found to be anisotropic, with $|g_{n\parallel}|/g_{n\perp}| = 0.62$. A comprehensive theoretical interpretation of the spin Hamiltonian parameters using eigenvectors precisely calculated from the crystal field interaction parameters yields $\mu(Nd^{143})/\mu(Nd^{145}) = +1.00883 \pm 0.00004$, $\mu(Nd^{143}) = -1.079 \pm 0.06$ nuclear magneton, $\mu(Nd^{145}) = -0.671 \pm 0.04$ nuclear magneton, $Q(Nd^{143})/Q(Nd^{145}) = +1.96 \pm 0.2$, $Q(Nd^{143}) = (+0.0206 \pm 0.003) \times 10^{-24}$ cm^2, $Q(Nd^{145}) = (+0.0105 \pm 0.002) \times 10^{-24}$ cm^2, $\langle r^{-3}(Nd^{+3}, 4f^3) \rangle = (36.9 \pm 4.5) \times 10^{24}$ cm^{-3}. An upper limit of one part in two thousand is established for the contribution, if any, of a contact term to the hyperfine interaction. The errors quoted are estimated standard deviations of the mean based upon internal consistency. A discussion of the errors and their sources is given. In particular, the precision of the determination of the nuclear moments μ and Q, of $\langle r^{-3} \rangle$, and of the contact term is limited mainly by the inaccuracies of the values of the crystal field parameters. Numerical values of the spin Hamiltonian parameters, crystal field eigenvectors, and relevant interaction multiplicative factors are tabulated. (auth)

33895 RESONANCE ABSORPTION OF GAMMA RAYS IN NORMAL AND SUPERCONDUCTING TIN. M. Yaqub and C. Hohenemser (Washington Univ., St. Louis). Phys. Rev., 127: 2028-35(Sept. 15, 1962).

A study of the resonant absorption of 23.8-kev gamma rays in Sn^{119} is made between 373 and 1.1°K by using the Sb^{119} K-capture parent. The source is prepared by bombarding natural Sn with 10-Mev deuterons in a cyclotron, and is thick enough to absorb resonantly a large portion of the recoilless photons emitted. By studying the self-absorption in this source between 373 and 60°K and taking into account the contributions to the intensity arising from resonant scattering, an average value of the Debye temperature θ is derived. In order to see if the phonon spectrum undergoes a change in passing from the superconducting to the normal phase, the counting rate is measured at several temperatures between 4.2 and 1.1°K, with and without a magnetic field strong enough to destroy the superconductivity of the source. Using the derived value of 140°K for θ, it is concluded that the change in θ between the two phases cannot be more than 0.76°K. (auth)

33896 MÖSSBAUER EFFECT IN Eu^{151}; POSSIBLE INFLUENCE OF OPTICAL BRANCHES. D. A. Shirley, M. Kaplan, R. W. Grant, and D. A. Keller (Univ. of California, Berkeley). Phys. Rev., 127: 2097-2100(Sept. 15, 1962). (UCRL-10168)

The Mössbauer effect is observed in the 21.7-kev transition in Eu^{151}. The absorption pattern is a single line, independent of temperature, as expected for an ion in which the ground level has J = 0. A lower limit of 0.92×10^{-9} sec can be set on the lifetime of the isomeric state. The 21.7-kev transition is thus about a factor of 100 slower than the single-particle estimate. The large discrepancy between the Debye temperatures required to fit the data of 77 and 295°K is attributed to the influence of optical branches. (auth)

33897 NUCLEAR ENERGY LEVELS OF C^{12}; TWO-STAGE REACTION $N^{14}(t,n)O^{16*}(\alpha)C^{12}$. M. G. Silbert (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 127: 2113-22(Sept. 15, 1962). (LADC-5334)

Alpha spectra from the triton bombardment of natural nitrogen are studied at laboratory angles of 30 and 90° with a double-focusing magnetic spectrometer. Observation of alpha groups from $N^{14}(t,\alpha)C^{12}$ allows the positions of energy levels in C^{12} to be investigated up to an excitation energy of 12.5 Mev. Levels are observed at 10.736, 10.809, 11.000, 11.078, 11.721, and 12.131 Mev. Standard deviations in these values range from 0.020 to 0.030 Mev. Levels at 5.51, 6.10, and 10.47 Mev are not seen. Certain structural features of the alpha continuum underlying C^{12} groups can be tentatively identified with alpha groups from the two-stage reaction $N^{14}(t,n)O^{16*}(\alpha)C^{12}$ proceeding through known levels in O^{16} near 15-Mev excitation. Cross sections are reported for various features of the alpha spectra, as well as for corresponding features of the proton spectra. (auth)

33898 CIRCULAR POLARIZATION MEASUREMENTS IN THE β DECAY OF V^{48}, Co^{56}, Fe^{59}, AND Cs^{134}. Lloyd G. Mann, Stewart D. Bloom, and R. J. Nagel (Univ. of California, Livermore). Phys. Rev., 127: 2134-7(Sept. 15, 1962). (UCRL-6831)

The β-γ circular-polarization angular correlation is measured for V^{48}, Co^{56}, Fe^{59}, and Cs^{134}. Since all of these decays (with one exception) are characterized by $\Delta J = 0$, $J \neq 0$, and $\Delta T \approx 1$, they possess the necessary elements for testing isospin conservation in allowed β decay. The asymmetry parameters are measured. The results are consistent in all cases with a very small Fermi matrix element and therefore support the validity of isospin conservation, with the doubtful exception of the 271-kev β-decay branch of Fe^{59}. However, in this case the extreme difficulty of disentangling the 271-kev branch from the 462-kev branch, which is a pure Gamow-Teller branch, renders this exception rather uncertain. The Cs^{134} result shows definite interference, but because of the large ft value the Fermi matrix element is still very small, in keeping with the other findings. (auth)

33899 POPULATION RATIOS OF Be^7, Li^7, AND B^{10} STATES FROM Li^6 ON Li^6 AND Be^9 AS FUNCTIONS OF BOMBARDING ENERGY. Robert L. McGrath (Univ. of Iowa, Iowa City). Phys. Rev., 127: 2138-42(Sept. 15, 1962).

The populations of Be^7 (0.431 Mev), Li^7 (0.478 Mev), and B^{10} (0.717 Mev) states are compared in the bombardment of Li^6 by Li^6 over energies from 1.2 to 2.8 Mev. The populations of the same Li^7 and B^{10} states are compared in the $Li^6 + Be^9$ reactions over energies from 1.5 to 2.9 Mev. It is found that the ratios of these populations are constant within experimental error. A simple tunneling model and a compound-nucleus model do not appear compatible with the data; however a "surface" interaction is consistent with the results. (auth)

33900 EFFECTS OF ANGULAR MOMENTUM AND GAMMA-RAY EMISSION ON EXCITATION FUNCTIONS. J. Robb Grover (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 127: 2142-50(Sept. 15, 1962). (BNL-6137)

Excitation functions for many compound nucleus reactions are strongly dependent on the competition between gamma-ray and particle emission in the final particle-emission step. This competition depends, in turn, mainly on the energies and spins of a relatively few levels in the product nucleus, namely, on the lowest energy level at every angular momentum J (these energies are designated by E_j). A method for making approximate calculations is described in which the influence of the competitive gamma-ray emission on excitation functions well above threshold is estimated, using assumed plausible distributions of the E_j's. It is found that larger values of the level density parameter a are required to achieve agreement of calculations with experimental data when the competitive gamma-ray emission is included than when it is neglected (i.e., practically equivalent to setting $E_j = 0$ for all angular momenta). An approximate analysis of experimental excitation functions for the reaction-pair $Ag^{109}(\alpha,n)In^{112}$ and $Ag^{109}(\alpha,2n)In^{111}$ suggests that $a > 12$ Mev^{-1}, assuming the level density expression $\omega(E) \propto E^{-2} \exp[2\sqrt{(aE)}]$, or $a > 7$ Mev^{-1} assuming $\omega(E) \propto \exp[2\sqrt{(aE)}]$. Alternatively, assuming $a \approx 16$ Mev^{-1} (in the first formula), consistent with values calculated from level spacings observed near neutron binding energies, it appears that the average value of the E_j's for angular momenta of $(^{11}/_2)\hbar$ to $(^{17}/_2)\hbar$ in In^{111} is roughly 2 to 2.5 Mev. It is suggested that instead of trying to extract a from excitation functions, it is perhaps more appropriate to try to extract information on the E_j distribution, using for this purpose values of a from other types of experiment. (auth)

33901 BRANCHING RATIOS AND MAGNETIC DIPOLE TRANSITION PROBABILITIES IN ODD-A ROTATIONAL NUCLEI. G. Goldring (Weizmann Inst. of Science, Rehovoth, Israel), H. M. Loebenstein, and R. Barloutaud. Phys. Rev., 127: 2151-8(Sept. 15, 1962).

Branching ratios are measured for gamma radiations from the second excited level in odd-A rotational nuclei. The magnetic dipole transition probability for the first member of the cascade transition can thus be measured in terms of the electric quadrupole transition probability for the crossover transition. Results are reported for Eu^{153}, Gd^{155}, Gd^{157}, Er^{167}, Yb^{173}, Lu^{175}, Hf^{177}, and Ta^{181}. Electric quadrupole transition probabilities can also be determined in some cases where mixing ratios E2/M1 are known. The M1 and E2 transition probabilities are compared with the corresponding quantities for the transition from the first excited state to the ground state. The ratios of M1 transition probabilities for the two transitions are in agreement with values predicted for collective rotational motion. The gyromagnetic ratios of the collective motion (g_R) for odd-Z nuclei are found to be consistently higher than the g_R for odd-N nuclei. (auth)

33902 INELASTIC SCATTERING OF 17-Mev PROTONS FROM Be^9, B^{10}, Ne^{20}, Mg^{25}, AND Mg^{26}. G. Schrank, E. K. Warburton, and W. W. Daehnick (Princeton Univ., N. J.). Phys. Rev., 127: 2159-79(Sept. 15, 1962). (PUC-1962-63)

Elastic and inelastic scattering of 17-Mev (center-of-mass energy) protons by Be^9, B^{10}, Ne^{20}, Mg^{25}, and Mg^{26} was studied using scintillation crystal spectroscopy. Angular distributions were obtained for most of the levels observed. All the angular distributions were characteristic of a direct interaction with initial- and final-state interactions. The differential cross sections were summed to obtain total cross sections which were compared to EL transition rates when known. For the larger (p,p') cross sections a strong correlation with the EL transition rates was found. This correlation was discussed. (auth)

33903 PROPERTIES OF THE TWO STATES IN Ca^{41} NEAR 9.87 Mev. L. K. Rangan, Gale I. Harris, and L. W. Seagondollar (Univ. of Kansas, Lawrence). Phys. Rev., 127: 2180-8(Sept. 15, 1962).

The close-lying pair of resonances in the $K^{39}(p,\gamma)Ca^{40}$ reaction, which corresponds to excitation in Ca^{41} of about 9.87 Mev, are measured to be at $E_p = 1575.5 \pm 0.8$ and 1580.0 ± 0.8 kev by comparison with the $Al^{27}(p,\gamma)Si^{28}$ resonance at 992 kev. Gamma spectra obtained for both resonances show both have strong transitions to the ground state and to the first excited state. Weaker cascades through higher levels are also shown. The angular distribution of the ground-state radiation from the $E_p = 1580$ kev level leads to an assignment of 2^+ for the level. The radiation from this level to the 3.35-Mev (0^+) first excited state appears enhanced, thus lending support to the suggestion that the 3.35-Mev level may have a stable deformation and that upon this level is built a band of vibrational states at higher excitation. Resonant absorption measurements on the ground-state radiation from the $E_p = 1575.5$ kev level give $\Gamma_t = 110 \pm 30$ ev and $\Gamma_{\gamma 0} = 1.36 \pm 0.25$ ev. For the $E_p = 1580$ kev level, the yield curve gives $\Gamma_t = 1060 \pm 200$ ev and a yield measurement gives $\Gamma_{\gamma 0} = 0.80 \pm 0.26$ ev. At both levels, the (p,α) cross section is measured to be ≤ 68 μb and thus $\Gamma_\alpha \leq 0.012$ and 0.068 ev for the lower and upper levels, respectively. The proton widths are thus 110 ± 30 and 1060 ± 200 ev. Arguments are given for J = 1 assignment for the lower level. An even parity assignment is favored slightly by the experimental data. The possibility of "cross excitation" between the levels in the resonant absorption measurements is considered. (auth)

33904 4.48-Mev LEVEL OF Ca^{40}. R. D. Bent, D. E. Blatchley, and W. W. Eidson (Indiana Univ., Bloomington). Phys. Rev., 127: 2188-91(Sept. 15, 1962).

The reaction $Ca^{40}(\alpha,\alpha'\gamma)$ is studied using particle-gamma coincidence techniques and a 22-Mev alpha-particle beam. The 4.48-Mev level of Ca^{40} is observed to decay strongly to the 3.73-Mev 3^- level. An upper limit of 5% is placed on the intensity of the ground-state transition. The weakness of the ground-state transition is strong evidence against a 1^- assignment for the 4.48-Mev level. This result, together with other data, indicates that the 4.48-Mev level is 5^-. (auth)

33905 TOTAL NEUTRON CROSS SECTION OF Pb^{208}. J. L. Fowler and E. C. Campbell (Oak Ridge National Lab., Tenn.). Phys. Rev., 127: 2192-7(Sept. 15, 1962).

Measurements are reported on the total neutron cross section of isotopically enriched Pb^{208} (99.75%) for neutron energies from 720 to 1890 kev with an energy spread of about 3 kev. In this region at least 85 resonances are observed, of which 24 are analyzed to give tentative spin assignments and reduced widths. The reduced-width estimates furnish evidence that the $J = 5/2$ resonances at 723 and 821 kev have even parity. Differential cross sections of normal lead measured with 50-kev energy spread at 1.2, 2.2, and 3.2 Mev are used in estimating the in-scattering correction for the total cross section data. (auth)

33906 NUCLEAR E1 OVERTONES. J. H. Carver, D. C. Peaslee, and R. B. Taylor (Australian National Univ., Canberra). Phys. Rev., 127: 2198-2205(Sept. 15, 1962).

The magnitude and energy distribution of nuclear E1 cross sections are considered in the light of evidence for a large, positive, collective shift in the giant resonance energy. Two secondary mechanisms appear relevant: quasi-deuteron or two-particle effects; and overtones of the fundamental E1 resonance, representing vibration of the nucleus as a whole. These overtones must exist on any mechanical model, and one object of the study is to point out their probable importance for real nuclei. Four types of rough experimental data indicate a first overtone intensity of order 25% relative to the fundamental. The parameters obtained are applied to yield: an estimate of $W_0 \sim 60$ Mev for the energy at which quasi-deuteron effects become predominant; predicted curves of $\int \sigma dW$ to finite upper limits, suitable for immediate comparison with experiment, in contrast to sum rules that require infinite upper limits in principle; a corrected estimate $y \sim 1$ for the nuclear exchange force parameter, indicating two-body forces in the nucleus that are relatively weak (attractive) in odd states; and a formula for nuclear polarizability. (auth)

33907 CROSS SECTIONS FOR THE $B^{11}(\gamma,\pi^-)C^{11}$ AND $B^{11}(\gamma,\pi^+)Be^{11}$ REACTIONS. Palmer Dyal and John P. Hummel (Univ. of Illinois, Urbana). Phys. Rev., 127: 2217-22 (Sept. 15, 1962).

Cross sections for the $B^{11}(\gamma,\pi^-)C^{11}$ and $B^{11}(\gamma,\pi^+)Be^{11}$ reactions were studied by measuring the radioactivities of the product nuclei in boron-containing samples that were irradiated with bremsstrahlung of maximum energy from 80 to 300 Mev. In both cases activity was observed below the thresholds for the meson production reactions. These below-threshold activities were studied in some detail and were believed to be mainly caused by low-energy reactions involving impurities in the target materials. Corrections were made to the yield data to remove the contributions from the low-energy reactions before the cross sections were calculated. The resulting cross sections for the production of C^{11} were about seven times those for the production of Be^{11}. The cross sections for the $B^{11}(\gamma,\pi^-)C^{11}$ reaction agreed with those calculated for surface production of pions. Although detailed theoretical calculations of the cross sections expected for the $B^{11}(\gamma,\pi^+)Be^{11}$ reaction were not made, the observed cross sections were qualitatively in agreement with those expected for surface production. (auth)

33908 THE QUADRUPOLE MOMENT OF THE STRONTIUM-87 NUCLEUS. H. Bucka, H. Kopfermann, and G. zu Putlitz (Universität, Heidelberg). Z. Physik, 168: 542-3(1962). (In German)

For the determination of the electric nuclear quadrupole moment, the hyperfine structure splitting of the $5s\ 5p\ ^3P_1$ term in the Sr I spectrum was measured by the double resonance method. From the frequency measurements the splitting factor A and the electric quadrupole interaction constant B were found to correspond to $\nu_{5/2-3/2} = |11/2\ A + 11/12\ B|$ and $\nu_{3/2-1/2} = |9/2\ A - 9/8\ B|$ at $A = -260.1(1)$ MHz and $B = -35.7(1)$ MHz. By assuming a slight deviation from the Russell-Saunders coupling, the value $Q = +0.36 \times 10^{-24}$ cm^2 was obtained for the electric nuclear quadrupole moment without the use of further corrections. (J.S.R.)

33909 PRODUCTION OF NEW ISOMERIC NUCLEAR STATES BY PHOTONUCLEAR REACTIONS ON ANTIMONY AND THALLIUM. R. Engelmann, V. Hepp, E. Kluge, H. Krehbiel, and U. Meyer-Berkhout (Universität, Heidelberg). Z. Physik, 168: 544-52(1962). (In German)

The systematic search for new short-lived isomeric states was continued by irradiation of an additional 32 selected elements with 26 Mev bremsstrahlung. Isomeric transitions were detected using a conventional scintillation spectrometer. Irradiation of antimony led to the production of a new (530 ± 50) μsec isomeric state which decays through emission of partially converted (62 ± 2) kev and (76 ± 3) kev gamma rays. The 530 μsec half life is tentatively associated with the 136 kev level in Sb^{122}. An apparent inconsistency in the previously proposed level scheme of Sb^{122} can be removed if the 3.5 min Sb^{122} activity is assigned to an isomeric level in Sb^{122} lying less than 15 kev above the 136 kev isomeric state. A new measurement of the half-life of this level yielded a value of (4.1 ± 0.2) min. Another new isomeric state with a (2.1 ± 0.2) msec half life was produced by irradiating thallium. The isomeric state decays by emission of two gamma rays of (335 ± 8) kev and (597 ± 12) kev which were found to be in coincidence. Irradiation of erbium led to the production of a short-lived isomeric transition which may be identical with a previously reported Ho isomer. Results are discussed in the appendix. (auth)

33910 FREQUENCY DISTRIBUTION OF NORMAL MODES IN GRAPHITE. B. C. Haywood and I. M. Thorson (Atomic Energy of Canada Ltd., Chalk River, Ont.). [1962]. Prepublication Copy. 21p. (AECL-1570)

The scattering of neutrons in the range 0.03 to 0.15 ev from graphite was studied using the Chalk River thermal neutron analyzer. Partial differential cross sections were obtained over the range of energy transfer 0.01 to 0.1 ev and momentum transfer 0.05 to 0.60 (ev-amu)$^{\frac{1}{2}}$ ($Q = 2$ $(Å)^{-1}$ to $Q = 13$ $(Å)^{-1}$) and compared to earlier measurements. A scattering law was derived and was analyzed to find the frequency distribution, which was then compared with theoretical values. (auth)

33911 A STUDY OF THE INELASTIC SCATTERING OF NEUTRONS IN A Ti–Zr ALLOY. N. A. Chernoplekov, M. G. Zemlyanov, and A. G. Chicherin (Academy of Sciences, Moscow). IAEA Preprint No. SM-30/49. 15p. (In Russian)

To be published in Proceedings of the IAEA Symposium on Inelastic Scattering of Neutrons in Solids and Liquids, Chalk River, Canada, 10-14, September 1962.

Using a time-of-flight neutron spectrometer, a study of the inelastic scattering of cold neutrons was made on a sample of a disordered Ti–Zr alloy with a composition corresponding to a zero average value of neutron coherent scattering amplitude. The particulars of the phonon spectrum of a two-component disordered system are discussed on the basis of the results obtained. (auth)

Particle Accelerators

33912 (BNL-6212) THE SEPARATED BEAM AT THE AGS— PERFORMANCE WITH ANTIPROTONS AND π^+ MESONS. C. Baltay, J. Sandweiss, J. Sanford (Yale Univ., New Haven); H. Brown, M. Webster, and S. Yamamoto (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract [AT-30-2-GEN-16]. 12p.

The use of the separated beam at AGS for antiprotons and mesons (π^+) is discussed. Beam design and layout is described. The target used for production of antiprotons is tungsten. An aluminum target is used for production of mesons (π^+). Beam tuning and counting is described. (M.C.G.)

33913 (DESY-A2.94) METHODEN ZUR AUFWEITUNG DES SYNCHROTRONSTRAHLS. (Method for Expanding the Synchrotron Beam). H.-J. Behrend (Deutsches Elektronen-Synchrotron, Hamburg). Aug. 7, 1962. 18p.

For production of an as-long-as-possible pulse both for production of gamma beams by means of closed orbit collisions and also for the ejection, it is necessary to expand the radiation in a radial direction since for energies smaller than about 5 Gev it possesses a very small cross section. Several methods of expansion are discussed. Expansion of the beam by means of a homogeneous high-frequency field by production of betatron resonance is described. Use of a high-frequency quadrupole field is shown to give better results. The sextupole field was also investigated. Statistical expansion is discussed. (M.C.G.)

33914 (IA-743) ON THE DUTY CYCLE OF CYCLOTRONS. Avivi I. Yavin (Israel. Atomic Energy Commission, Tel-Aviv). June 1962. 8p.

The poor duty cycle, 1 to 6%, of present day cyclotrons is mainly due to: r-f extraction from the ion source, r-f defocusing caused by part of the r-f phase, loss of phase due to relativistic effects, phase bunching at small radii, and inefficient extractors. Possible methods of improvement are: d-c extraction from the ion source, introduction of focusing grids, introduction of isochronous fields, squaring of the r-f wave from, and Mobley magnets and other debunchers. (auth)

33915 (PPAD-464D) THE FERRITE BIASING SYSTEM FOR THE RADIO FREQUENCY CAVITIES OF THE PRINCETON-PENNSYLVANIA 3 Bev PROTON SYNCHROTRON. Grahame H. Rees (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Aug. 29, 1962. Contract AT(30-1)-2137. 30p.

A description is given of the ferrite biasing system for the four tuned radio frequency cavities of the synchrotron. Each ferrite loaded double cavity has a single turn bias winding which is driven to a peak current of 13,500 amperes by a push-pull transformer arrangement. There is automatic tap changing of the transformer to accommodate the variable impedance load (for power considerations). The programming and frequency response of the system have to be such that each cavity can operate as the resonant circuit of a self tracking radio frequency amplifier over the frequency range 6.5 to 30 Mc at the 20 cps repetition rate of the synchrotron. Between acceleration cycles it is necessary to program the ferrite to a given magnetic state, near that of maximum radio frequency permeability. (auth)

33916 (UCRL-10132) BEVATRON INDUCTION ELECTRODES. Fred H. G. Lothrop (California. Univ., Berkeley. Lawrence Radiation Lab.). July 9, 1962. Contract W-7405-eng-48. 16p.

Redesign and relocation of the primary-standard induction electrode for monitoring the beam intensity of the Bevatron was undertaken as a part of the Bevatron major improvements program. A radius-indicating electrode structure was also built. Electronics was devised so that the induced signals on the electrodes could be brought through the vacuum wall of the Bevatron with minimum loss of information. The electrode assemblies were calibrated in terms of volts induced per circulating proton. The radial sensitivity of the radius electrode structure was calculated from the geometry of the electrode and measured with a thin search wire. The average induced voltage on the standard electrode is 109 mv per 10^{11} protons. The radius-indicating structure has a sensitivity of 7.4% of full signal change per inch of radius change. (auth)

33917 (CEA-tr-X-476) SÉCURITÉ ET DOSIMÈTRIE AUTOUR DES ACCÉLERATEURS DE HAUTE ÉNERGIE À FLUX PULSÉ. (Safety and Dosimetry near High Energy Accelerators with Pulsed Flux). Mario Ladu. Translated into French from Minerva nucleare, 5: 184-6(Aug. 1961). 14p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, as abstract no. 7187.

33918 PULSATION OF A 600-kev COCKCROFT-WALTON ACCELERATOR. F. Cordero and F. Verdaguer (Junta de Energia Nuclear, Madrid). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 58: 85-94(Mar.-Apr. 1962). (In Spanish)

The request for diffusion measurements with pulsed neutron sources necessitated pulsing the 600 Kev Cockcroft-Walton accelerator at JEN. This is accomplished by pulsing a Penning-type cold cathode ion source; to synchronize the source with the time analyzer a signal derived from the target ion current is used. The pulse generator and the working conditions of the ion source and the accelerator are described. The current pulses are sinusoidal and the adjustment of the parameters which are required for the experiments is easily made. (auth)

33919 CONTROL OF THE MAGNETIC FIELD CONFIGURATION OF A CYCLOTRON. A. P. Babichev, N. I. Venikov, A. S. Knyaznyatov, R. A. Meshcherov, E. S. Mironov, L. M. Nemenov, N. D. Fedorov, and Yu. A. Kholmovskii. At. Energ. (USSR), 13: 125-34(Aug. 1962). (In Russian)

Plans are being made to change the cyclotron of the I. V. Kurchatov Institute of Atomic Energy into a device with azimuthal variation of the magnetic field configuration with adjustable energy. In order to obtain the necessary data, experiments were carried out on a 1/5 model of the 1.5-meter cyclotron. Carbon steel was used for the yoke of the magnet; the windings were provided with forced air cooling. The tests were aimed at the determination of the optimum geometry of the magnet while maintaining a constant configuration of the field; correction of the field was carried out by means of circular coils placed in the operational gap placed between the covers and the windings used for creating the first harmonic. On the basis of the

results obtained, the correction of the azimuthally variable field was calculated and the correctional elements were chosen. The data indicated that the action of the azimuthally variable magnetic field requires the same circular coils as the axially symmetrical field. (TTT)

33920 THE PHOTONEUTRON YIELD AND SHIELDING PROBLEMS OF THE CYCLIC HIGH-ENERGY ELECTRON ACCELERATORS. A. V. Elpidinskii and I. N. Fetisov. At. Energ. (USSR), 13: 140-4(Aug. 1962). (In Russian)

In the design of shields for cyclic accelerators usually only the bremsstrahlung is taken into account, although present-day high-energy and high-current accelerators are actually also strong fast-neutron sources. Two distinct energy levels must thereby be taken into account: neutrons with energies of several Mev formed by photonuclear reactions in the giant resonance range and neutrons with tens and hundreds of Mev, formed beyond the threshold level of photomeson processes. In spite of its lower intensity, the second group represents the same hazard as the first one. The neutron yield per second Q from the absorption of E_0-energy neutrons by thick layers was found to be approximately $Q = 1.5 \cdot 10^{-4} NE_0$ (N = number of electrons accelerated per second); the expression is correct for $E_0 \geq 30$ Mev. The neutrons represent a larger local danger than the bremsstrahlung only if thick layers of heavy materials (>15 cm of Pb or >35 cm of Fe) are used. (TTT)

33921 THE 680-Mev SYNCHROTRON OF THE PHYSICAL INSTITUTE OF THE USSR INSTITUTE OF PHYSICS. A. I. Gryaznov, Yu. N. Metal'nikov, S. S. Molchanov, et al. At. Energ. (USSR), 13: 228-34(Sept. 1962). (In Russian)

The new 680-Mev synchrotron is a weak-focusing accelerator with internal high-voltage injection. Its design is based on the components of the 180-Mev accelerator, used as a model of the 10-Bev machine of the Joint Institute of Nuclear Investigations. By using an 800-kev Van de Graaff accelerator the number of electrons reaching the limiting energy was (5 to 6) $\times 10^9$; tests are in progress to increase this level. The electromagnet of the synchrotron consists of four 2-m radius circular sections subdivided by a 67-cm long interspace. The initial rate of change of the magnetic field tension H is 20,000 oersted/sec. The chamber is made of porcelain; a large portion of the internal surface is covered with aquadag,—other portions are covered with a 50-micron thick Ag layer. The Van de Graaff accelerator operates under a nitrogen atmosphere under a pressure of 5 to 6 atmospheres, under a relative humidity of 0.05%. The energy of the injected electrons can be stabilized at the desired level with great precision. The resonance acceleration of the electrons is carried out in 2 stages. In addition to the auxiliary control and adjustment devices, the startup and shakedown operations are described. (TTT)

33922 CREATION OF PERMISSIBLE INJECTION CURRENTS IN A STRONG-FOCUSING PROTON SYNCHROTRON. I. M. Kapchinskii. At. Energ. (USSR), 13: 235-40(Sept. 1962). (In Russian)

The highest energies of accelerated particles, 25 to 30 Bev, are currently obtained by means of strong-focusing synchrotrons; for still higher energies linear accelerators with strong magnetic focusing are being designed. In proton synchrotrons the increase of beam intensity is connected with the injection; therefore an attempt was made to increase the injection pulse current by solving the problem of Coulomb interaction of the particles in the accelerated beam. The limitations of the peak current of the accelerated beam in a linear ionic accelerator with magnetic focusing were determined. One of the important technical problems that had to be solved involved the requirement of charging the accelerating system with the beam current which necessitates a sufficiently high frequency power supply together with compensation for the phase shift of the accelerating voltage; another problem is presented by the decrease of the Coulomb frequency of the transversal oscillations in the front portion of the injector. (TTT)

33923 ON THE OPERATION OF ELECTRON SYNCHROTRON AT THE INSTITUTE FOR NUCLEAR STUDY, TOKYO. H. Kumagai, S. Yamaguchi, Y. Kobayashi, et al. (Tokyo Univ.). Japan. J. Appl. Phys., 1: 66-7(July 1962). (In English)

The present characteristics of the electron synchrotron are tabulated. Operation was initiated in Nov. and Dec. 1961, and an electron energy of 750 Mev was obtained. A maximum intensity of 1.2×10^9 electrons/pulse or 2.5×10^{11} electrons/sec was also obtained. (D.L.C.)

Plasma Physics and Thermonuclear Processes

33924 (AFCRL-730) SPACE CHARGE WAVES IN AN ELECTRON BEAM OF GAUSSIAN CROSS SECTION. O. E. H. Rydbeck and M. H. Fischer. THE INTEGRAL EQUATION OF TRAVELING WAVE TUBES WITH ELECTRON BEAMS OF ARBITRARY CROSS SECTION. O. E. H. Rydbeck. Research Reports Nos. 13 and 14. (Chalmers Tekniska Hogskola, Goteborg. Forskningslaboratorium for Elektronik). 1960. Contract AF61(052)-159. 82p. (AD-271888)

The space charge waves of the Gaussian beam were studied. Space charge wavelengths, and thereby the plasma frequency reduction coefficients, were calculated. The physical problem is stated in equations. The general theory of the second order linear differential equations was applied and approximate solutions were constructed. The Gaussian beam was compared with the homogeneous beam and a beam with density varying as 1/r. A rigorous formulation is presented for the integral equation of traveling wave tubes with electron beams of arbitrary cross section. It is shown that the integral equations have general applicability in electron beam-structure interaction studies. A bibliography is included. (M.C.G.)

33925 (ARL-62-399) THE SPECTRA OF HIGHLY IONIZED LIGHT ELEMENTS IN A HIGH-TEMPERATURE PLASMA. Technical Note No. 7. K. Bockasten, R. Hallin (Uppsala Univ. Inst. of Physics); and T. P. Hughes (Associated Electrical Industries, Ltd. Research Lab. Aldermaston, Berks, England). [May 8, 1962]. Contract AF 61(052)-170. 23p.

By introducing small proportions of appropriate gases into a high-temperature hydrogen plasma produced by the toroidal discharge apparatus Sceptre IV, the spectra of highly ionized B, C, N, O, F, and Ne were obtained and investigated in the wavelength range 200 to 7000 Å. New as well as previously observed resonance lines of Li(I)-like ions were measured. Hydrogenlike transitions of O(VI) were observed, the wavelengths of which agree within the experimental errors with the predictions of a polarization formula. According to this formula the ionization limit of O(VI) is 1114010 cm^{-1}. New lines of Ne(VII), Ne(VI), and Ne(IV) were measured and new energy levels were obtained. (auth)

33926 (ASD-TR-61-605) THE DECAY OF ELECTROMAGNETIC RADIATION IN GASEOUS DISCHARGES. A. D. Kaske and H. J. Oskam (Minnesota. Univ., Minneapolis). Oct. 1961. Contract AF 33(616)-5479. 47p. (AD-273249)

One of the important parameters determining the properties of gaseous plasmas is the value of the average electron energy. For instance, the phenomena occurring in disintegrating plasmas depend strongly on this energy and thus on the transient behavior of the average electron energy. Calculations relating to the characteristic time constant of the electron energy for electron-neutral and electron-ion interactions are presented. A method is described for measuring this time constant and preliminary results are given. (auth)

33927 (LAMS-2754) QUARTERLY STATUS REPORT OF THE LASL CONTROLLED THERMONUCLEAR RESEARCH PROGRAM FOR PERIOD ENDING AUGUST 20, 1962. (Los Alamos Scientific Lab., N. Mex.). Sept. 1962. Contract W-7405-eng-36. 19p.

Progress is reported on controlled thermonuclear reactions. Topics covered include Picket Fence IIB, Picket Fence III, coaxial gun research, plasma gun research facility, fast gas valve, particle energy analyzer for cusp geometries, development of coaxial gun for injection into magnetic fields, transverse magnetic field injection, Scylla I Zeeman experiment, Scylla I x-ray spectrography, plasma analysis of injected Scylla III, Scylla IV, ruby laser, 50-kv ignitrons, and parallel plate capacitors. (M.C.G.)

33928 (NP-12090) RESEARCH ON IMPROVED THERMIONIC CONVERTER FOR SPACE OPERATIONS. Final Report, January 1, 1960–December 31, 1961. J. R. Fendley, K. G. Hernqvist, F. M. Johnson, and J. D. Levine (David Sarnoff Research Center, Princeton, N. J.). Dec. 31, 1961. Contract AF19(604)-6175. 139p.

A theoretical analysis of the space charge problem for a Cs plasma diode shows that operating conditions can be achieved for which there exists no simultaneous solution of the space charge and converter equations which relate current, voltage, and load impedance. These conditions correspond to those for which internal relaxation oscillations were experimentally observed in a Cs vapor type thermionic energy converter. Examination of the normalized distance parameter used in the analysis indicates that potential distributions having a large number of potential maxima and minima may exist in the Cs plasma diode. This explains some irregularities found in the load characteristic and in plasma temperature measurements for the Cs diode. The conversion of heat into electromagnetic energy is achieved by utilizing the intrinsically unstable space-charge properties of a thermionic Cs plasma diode. Experimental studies of this phenomenon are described. A physical model for the observed relaxation oscillations is proposed which is in qualitative agreement with experiments. A novel method of representing the potential energy diagram for the plasma is described; this method facilitates the understanding of the interaction between plasmas and solids. Based on this model, a detailed plasma energy balance for different types of cathode materials is given. Experimental studies of plasma synthesis are described where ions and electrons originate at different sources. The experimental tube operating as an energy converter had a power output of about 0.55 w/cm^2 at a cathode temperature of 1100°C. Theoretical and experimental studies of the duo-emitter diode are described. In this diode an electron emitter and an ion emitter are facing each other. This geometry simulates the plasma triode geometry and allows studies of plasma generation as well as cathode and ion emitter materials and their interaction. Microwave and d-c experiments corroborate the theory. Some physical properties of the Li ion emitter Beta-Eucryptite were investigated and the application of this material for the production of an "electron-Li ion" plasma are described. Beta-Eucryptite is a ceramic material which has the ability to emit Li ions when heated to 1000 to 1300°C. In contrast to other types of ion emitters using the process of resonance ionization of neutral atoms on a hot surface, the alkali metal is here supplied not from the vapor phase but is stored in the emitter itself. In this sense β-eucryptite is a true ion emitter. This compound is one of the most copious ion emitters known. A theory is developed for ion emission from film coated metal surfaces. Based on this theory calculations are made of the ion emitter temperature (T*), which corresponds to the onset of saturated ion emission. T* is found to be dependent on the physical properties of the metal, the film, and on the film atom arrival rate. Theoretical and experimental values of T* are in excellent agreement. For Cs films at constant Cs atom arrival rate, T* is expected to vary about 200°C among the transition metals. For each metal, an increased Cs atom arrival rate corresponding to a change in the Cs bath temperature of 100°C cause T* to increase by about 300°C. Experimental studies of the plasma triode are described. Using the duo-emitter diode geometry tests of the performance of a large number of ion emitter materials were made in the presence of the L-cathode. It was found that Hf and graphite give excellent ion emission at temperatures equal to or lower than that of the L-cathode. The construction of a plasma triode having a common heat source for the two emitters is described. This structure uses a metallized ceramic base onto which the heater, the cathode and the ion emitter are brazed. This assures a uniform temperature distribution for the emitter. A discussion of the relative merits of three approaches to low temperature thermionic power conversion is made. These are the ball-of-fire mode of hot cathode arcs, the plasma triode, and the plasmatron. For heat source temperatures above 1300°C the arc discharge Cs diode is preferred due to its simplicity of construction. In the intermediate temperature range (1100 to 1200), factors such as reliability and life, which are not known at the present time, represent important factors in the evaluation. Below 1100°C, the plasmatron offers most promise. The conception and evolution of the basic principles of thermionic energy conversion, the newest of the heat-to-electricity conversion methods are described. The application of thermionic energy converters to its ideal heat source, the fission reactor, is discussed. It is believed that the state of the art is far enough advanced to make such a thermionic-reactor system practical within the next decade. Subjects for future research suggested by the work done under this contract are summarized. (auth)

33929 (NP-12131) THE WAKE OF A CHARGED PARTICLE MOVING THROUGH A PLASMA WITH MAGNETIC FIELD. Technical Report 401. Saroj K. Majumdar (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics). Apr. 12, 1962. Contract DA-36-039-sc-78108. 38p.

The motion of a charged particle through a low-density electron plasma placed in an external constant magnetic field was investigated by using transport equations. The motion of the particle in the direction of the applied magnetic field is considered in some detail; the particles moving at right angles to the magnetic field are considered very briefly. The charge density developed in the medium

as a result of interaction of the medium with the moving particle through long-range Coulomb force is evaluated for the wavelength, λ, which is such that $R > \lambda > \lambda_D$, where R is the distance from the moving particle, and λ_D, the Debye wavelength. Three types of charge-density waves were found to be associated with the moving test particle. One is a "plasma electron" wave that exists only for velocities of the test particle that are greater than the average thermal speed of the plasma electron; this wave also shows a Mach cone distribution. The second is an elliptically shaped "extra-ordinary" electromagnetic wave that exists for all velocities of the test particle, and is coupled to the plasma electron wave. The third is an almost spherical weak wave associated with the ordinary electromagnetic wave. This third wave is not coupled to the other waves within the range of approximation considered here, and it goes over to an exponentially decreasing charge distribution in the limit of very small magnetic field. (auth)

33930 (R62SD8) INTERACTION OF MICROWAVE RADIATION WITH A WEAKLY IONIZED GAS. A. Peskoff (General Electric Co. Missile and Space Div., Valley Forge Space Technology Center, King of Prussia, Penna.). Feb. 1962. Contract AF 30(602)-1968. 31p.

Propagation of intense microwaves in a plasma is studied. Simplified considerations are used to study the energy gain of an electron acted on by an alternating electric field, collisions with heavy particles, and collisions with other electrons. The conditions, under which each of these instances is important, are illustrated. The Boltzmann equation is applied to a plasma in which conditions vary slowly compared with the time-variation of the applied microwave field. Elastic, excitation, and ionization collisions are included in the analysis. The current-versus-voltage relation is studied for several idealized collision cross sections under steady state conditions. The dispersion relation (dependence of the wave-number on the microwave frequency) is derived, and is found to depend on the electric field intensity. A variational principle is given which may prove useful in finding the ionization rate, using a trial function for the electron velocity distribution function. (auth)

33931 (UCRL-6700) THE EFFECT OF CHARGE SEPARATION ON NONLINEAR WAVES IN A COLLISION-FREE PLASMA (thesis). Fred Alan Wolf (California. Univ., Livermore. Lawrence Radiation Lab.). June 30, 1962. Contract W-7405-eng-48. 171p.

Nonlinear plane wave motions of low-density fully ionized plasma propagating perpendicular to an applied magnetic field were investigated previously. The solutions found consisted of plane periodic waves and solitary symmetric pulses with a characteristic length much smaller than the mean free path. To investigate the physical significance of an upper bound or critical Mach number of stationary waves and the obvious violation of charge neutrality which occurs at the pulse center when the plasma is "hot," two plasma models were considered. In the first a one-dimensional plasma free of magnetic interaction was assumed. The solutions consisted of solitary pulses and periodic waves which are connected to the pulses if dissipation is introduced. In the second the solutions obtained previously for a plasma in a magnetic field were re-examined without neglecting the plasma pressure or the charge separation. It was found that the solutions differed insignificantly from the magnetic solutions previously obtained. The outstanding exception was the behavior of the longitudinal electric field at the upper limit of Mach number, which was found to be well-behaved and continuous at the pulse center. For both models the appearance of a charge layer for waves at critical Mach number and above is attributed to the fact that stationary plane waves are only possible if the ions in the undisturbed plasma follow trajectories from minus to plus infinity when viewed in the wave reference frame. Having ions with energies less than the maximum electrostatic potential energy thus produces an unphysical discontinuity in the electric field because the ions cannot climb the potential hill and cannot reflect from it. Consequently, they are carried along by the wave at the peak potential as a snow plow carries snow. (auth)

33932 (UCRL-6942) SELF-CONSISTENT DISTRIBUTION OF ELECTRONS IN THE ASTRON E-LAYER. Warren Heckrotte and Kelvin Neil (California. Univ., Livermore. Lawrence Radiation Lab.). June 8, 1962. Contract W-7405-eng-48. 22p.

The E-layer of the Astron thermonuclear machine is a cylindrical sheet of relativistic electrons. The electron density is to be such that the self-field of the layer in its central region is greater than the externally applied field, thus providing closed lines of magnetic field. The injection system and the external magnetic field are to be controlled so that the radius of the layer is approximately uniform along its length. In this calculation the E-layer is assumed to be of zero thickness, uniform radius, and finite length. The electrons are relativistic with a unique canonical angular momentum, and the layer is charge-neutralized. The magnetic field configuration and the self-consistent electron distribution in phase space are calculated. Results indicate that the layer is stable against the axial bunching instability. The layer is stable against the B_θ instability until the magnetic-self field is 20% greater than that necessary for field reversal. The problem of providing the time-dependent external field required to insure the desired layer properties is defined but not solved at this time. (auth)

33933 (UCRL-6947-T) A PLASMA–TRAVELING WAVE INTERACTION. Daryl D. Reagan (California. Univ., Livermore. Lawrence Radiation Lab.). June 5, 1962. Contract [W-7405-eng-48]. 7p.

A traveling wave disturbance can move in the direction parallel to an axial magnetic field in a confined plasma, producing sinusoidal compression and expansion. Such a disturbance might, for example, be produced by external coils. Approximate solutions of the Boltzmann equation are described which give "perpendicular" and "parallel" temperatures, density, and axial drift speeds for electrons and ions, and for the induced axial electric field in such a disturbed plasma. Necessary conditions for a steady state (measured in a frame moving with the disturbance) are discussed. Results for disturbance frequencies near the electron collision frequency, but below the ion cyclotron frequency are included. A case is described in which ion temperature is several times greater than the electron temperature. (auth)

33934 (UCRL-13045) CALORIMETRIC STUDIES OF PLASMA HEATED BY ADIABATIC MAGNETIC COMPRESSION. Final Report. T. O. Passell (Stanford Research Inst., Menlo Park, Calif.). Aug. 31, 1961. For Univ. of California Lawrence Radiation Lab., Livermore. Contract [AT(04-3)-115]. Subcontract No. 122. 57p.

The quantity of plasma energy which escapes the confinement region between two magnetic mirrors was determined by thermistor calorimeters just outside the region. The amount of plasma energy escaping transverse to the magnetic field under various experimental conditions at the plane midway between the mirrors was found

to agree with that measured by an electron scintillator probe sensitive only to electrons with energy greater than 9 kev. The total energy escaping via the mirror loss cone (in velocity space) opposite the axially positioned plasma source was approximately 1 joule, about 1000 times the total energy of the electrons observed by a scintillator probe. The behavior of the total energy escaping through this mirror loss cone as a function of compression ratio, ambient gas pressure, and delay between source firing time and the onset of magnetic compression led to the tentative conclusion that the energy observed is from plasma heated during the initial few tens of microseconds of the magnetic field increase. Escape of essentially all the initially trapped plasma via scattering terminates heating at this time, early in the 460-microsec compression period. A fraction ($\sim 10^{-4}$) of the initially trapped plasma avoids large-angle scattering and gives rise to the ~25-kev-electron plasma component previously studied by scintillation probes. (auth)

33935 THE COLLECTIVE AND SINGLE PARTICLE EXCITATION OF A HIGH DENSITY ELECTRON GAS. Julius Ranninger (Universität, Vienna). Acta Phys. Austriaca, 15: 283-99(1962). (In German)

An idealized high-density electron gas with Coulomb interaction was treated using the Feynman-Dyson method in the multi-body problem. The Gell-Mann and Brueckner solution method was transposed to the Feynman method in order to calculate the effective Coulomb potential and the low-lying states of the gas. A propagator $Q(q,\epsilon_q)$ was constructed for the density fluctuations. An iteration of $Q(q,\epsilon_q)$ leads to the propagator $\Gamma(q,\epsilon_q)$, which corresponds to the polarization of the medium as a result of the charge density fluctuations. This propagator is taken as the effective Coulomb potential, which is proved to be shielded. The infrared divergences of the selected Coulomb potentials were thereby eliminated by the iteration method. The screening pulse is shown to be proportional to $r_s^{\frac{1}{2}}$, and r_s is proportional to the electron gas density. The plasma frequency was chosen as the pole of (q,ϵ_q). For perturbation pulses q, which is larger than a given value q_{cr}, the plasma oscillations are unstable and decay into pair states with finite lifetimes. The energy of the interacting electrons as a function of their pulse was shown as poles of the single particle Green functions, whereas the electron self-energy was taken with the effective Coulomb potential $\Gamma(q,\epsilon_q)$ for the self-energy graphs. The energies of the elementary excitations were obtained as the difference of two particle energies (one particle within, and the other without the Fermi sphere) in a development in r_s. (tr-auth)

33936 NEW METHOD FOR DETERMINING THE THERMODYNAMIC FUNCTIONS OF DENSE GASES AND PLASMAS. O. Theimer and R. Gentry (New Mexico State Univ., University Park). Ann. Phys. (N. Y.), 17: 93-113 (Jan. 1962).

A method for calculating the partition function of real gases is developed and applied to a system of point charges without repulsive core, e.g., a fully ionized hydrogen gas. The electrostatic energy $\overline{U}$ of the total system is represented as a function of the Fourier coefficients (A_s) of the particle density, and the configuration integral is evaluated by direct integration in the function space generated by the A_s. To this purpose, the A_s are treated as stochastic variables characterized by a multivariate probability density that must be determined. The potential of mean force, W(r), is found equal to $(Z^2e^2/r)\exp(-r/h)$ (Ze = ionic charge, h = Debye shielding length). The radial distribution function g(r) is determined as $g(r) = \exp[-W(r)/kT]$, and the part of $\overline{U}$ proportional to the total particle number N is found. (auth)

33937 THEORY OF FLUCTUATIONS IN A PLASMA. Setsuo Ichimaru (Univ. of Illinois, Urbana). Ann. Phys. (N. Y.), 20: 78-118(Oct. 1962).

A theory of electron-density fluctuations in a two-component plasma of electrons and positive ions is developed within the random phase approximation. A dielectric formulation is used to describe the fluctuations; investigation of various examples clarifies such facets as collective and individual aspects of fluctuations. It is shown that the collective part of the fluctuation spectrum can also be obtained from the kinetic equations, which describe the time rate of change in the distributions of collective and individual-particle modes resulting from the excitation of collective oscillations by fast electrons and their decay into individual-particle modes. It is shown that the collective part of electron-density fluctuations exhibits a huge increase as the plasma approaches, from a region of stability, a critical point corresponding to the onset of plasma wave instabilities; consideration of the theory of electromagnetic wave scattering leads to the prediction of enormously enhanced scattering of the electromagnetic radiation at certain angles, a phenomenon analogous to the critical opalescence for a liquid–gas phase transition. The influence of scattering of the holes by impurities (for a plasma in a semiconductor) is studied, and it is found that impurity scattering acts to shift the position of the onset of the instability, but does not alter appreciably the existence of critical fluctuations in the vicinity of the critical point. It is also shown that the electron-density fluctuation spectrum obeys a certain sum rule. It is demonstrated that the method of superposing the dressed particles (electrons or ions plus their associated screening clouds) is a direct consequence of the random phase approximation. (auth)

33938 INTERACTION OF ELECTROMAGNETIC WAVES WITH PLASMAS OF HYPERSONIC FLOWS. Herbert S. Glick (Cornell Aeronautical Lab., Inc., Buffalo). ARS (Am. Rocket Soc.) J., 32: 1359-64(Sept. 1962).

Problems involving the interaction of electromagnetic waves with the plasma sheath surrounding a hypervelocity vehicle lead to new and challenging areas of research. Communication "blackout" and the tasks of locating reentering ICBM warheads and of discriminating such warheads from decoys by microwave methods are examples of important problems of this type. It is shown that, due to the complexity of the aerodynamic, chemical kinetic, and electrodynamic phenomena, useful small-scale experiments are not possible for many problems of interest. A new hypersonic shock tunnel with a test section 6 ft in diameter has been built. The capabilities of this tunnel for the study of problems involving the interaction of electromagnetic waves and hypersonic plasmas are discussed and some recent experimental results reported. The communication blackout problem for a lifting hypersonic vehicle, such as the Dynasoar, is considered as a problem to be studied in this shock tunnel. It is shown that two useful approaches can be followed, one leading to the gathering of test data for various configurations, and the other leading to the assessment of the validity of various schemes for the amelioration of the problem. (auth)

33939 PRODUCTION OF A HIGH ENERGY, QUASI-THERMAL PLASMA. R. G. Meyerand, Jr., E. C. Lary, and F. Salz (United Aircraft Corp., East Hartford, Conn.). ARS (Am. Rocket Soc.) J., 32: 1365-8(Sept. 1962).

The production of a high-temperature, high-density plasma by the transmission of a high-energy space-charge-

neutralized ion beam through a cusped magnetic field was studied. The high-energy beam is produced by using an electrostatic gradient in a space-charge neutral plasma to accelerate the ions to high velocity. The function of the cusped magnetic field is to transform a significant portion of the streaming energy of the particles into the energy of rotation about the particle guiding center. In this way a velocity randomization, or quasi-thermalization, of the beam is achieved. An analysis of electrostatic gradients in nonthermal plasmas is presented and compared to experiment. A simplified model of the energy transfer mechanism in the cusp was used to predict the fraction of streaming energy converted to rotational energy and was verified by the computation of actual particle trajectories using an analog computer. Experiments were performed in which a plasma beam has been injected into a cusped magnetic field and which verify that a significant portion of the streaming energy has been converted to rotational motion and that quasi-thermalization at a high temperature has been achieved. (auth)

33940 CHARACTERISTICS OF THE ARC IN A GERDIEN-TYPE PLASMA GENERATOR. M. T. Dooley, W. K. McGregor, and L. E. Brewer (Aro Inc., Arnold Air Force Station, Tenn.). ARS (Am. Rocket Soc.) J., 32: 1392-4 (Sept. 1962).

The characteristics of the arc in a d-c arc plasma generator having a Gerdien-type electrode configuration are described. Particular emphasis is placed on the jet structure and its influence on the use of this type of generator as a research, hot gas source. An explanation of the experimental methods used to determine the true arc configuration is included. These methods consisted of probe studies and electrode configuration studies. The results show that at atmospheric pressure the observed flame exiting from the generator orifice is in reality the envelope of many blown arc channels. (auth)

33941 ACCELERATION OF A CONDUCTING GAS BY A TRAVELING MAGNETIC FIELD. V. B. Varanov. ARS (Am. Rocket Soc.) J., 32: 1449-52(Sept. 1962).

The equations of magnetohydrodynamics are used to consider the acceleration of a conducting gas. Formulas and graphs are given for the velocity, density, pressure, and temperature for isothermal acceleration and for acceleration in channels of constant or slightly expanding cross section. The magnetic field induced in the gas is neglected; so is the viscosity. The speed of travel increases with the frequency; means of accelerating a conducting gas to speeds of 10 to 12 km per sec are examined. The external electric field is assumed to be zero, and all quantities are taken to be functions only of x, the distance along the channel. (auth)

33942 THE QUASILINEAR THEORY OF PLASMA (THE THEORY OF THE SLIGHTLY TURBULENT PLASMA). A. A. Vedenov. At. Energ. (USSR), 13: 5-24(July 1962). (In Russian)

The quasilinear plasma theory describes the dynamics of the interaction of resonance particles with waves; these processes may be considered when the energy of plasma oscillations is considerably smaller than the thermal energy of all the particles while simultaneously exceeding slightly the energy of thermal noises generated by the plasma waves. The theory involves the separation of the distribution function of the particles into rapidly oscillating and slowly changing portions, calculating the effect of the mean square of the oscillating portion on the slowly changing fraction making use of a method similar to Van der Pol's nonlinear mechanics. Processes taking place in a plasma with collective excited degrees of freedom, – such as the growth of the noise in the unstable plasma, interaction of the charged-particle beam with the plasma and the extinction of the plasma wave, – are taken into consideration. The properties of the stationary, slightly turbulent state which arises in the plasma when a current passes through it, are examined together with the anomalous transversal diffusion of the plasma in a magnetic field. Attention is given also the the "threshold absorption" of high-amplitude waves, leading to the collision-free heating of the particles. The quasilinear theory may be useful for solving the following problems: dynamics of the formation of instabilities which cause uniformization of the distribution function; study of three-dimensional spectra and the development of inhomogeneities, and study of the nonlinear approximation by making use of the hydrodynamic characterization of the system. (TTT)

33943 GENERALIZED MAGNETOHYDRODYNAMIC EQUATIONS FOR PLASMA SYSTEMS WITH LARGE CURRENTS. Willis Lynn Everett (Univ. of Michigan, Ann Arbor). Dissertation Abstr., 23: 591-2(Aug. 1962).

Differential equations for number densities, mean velocities, temperatures, stresses, and heat fluxes of the electrons and ions, obtained by taking velocity moments of the Boltzmann equations, were closed out by utilizing Grad 13-moment approximations for the distribution functions. The equations, coupled with Maxwell's equations, constitute a closed set. The approximate distribution function, for a given type particle, is such that the first term is Maxwellian in a coordinate system moving with the mean velocity of those particles; the higher order terms are nonsymmetric in velocity space and have for coefficients the non-hydrostatic (traceless) stress tensor and the heat flux vector defined relative to the same mean velocity. The range of validity of the resulting magnetohydrodynamic equations is anticipated to extend to systems in which the difference in flow velocity of plasma constituents is not negligible relative to the thermal velocity of the electrons. By limiting attention to systems with slowly varying flows, it was found possible to exhibit transport properties to third order in the ratio of the difference in constituent flow velocity to the electron thermal velocity. Transport properties may also be exhibited for systems in which the above ratio is large.

33944 PROPAGATION OF LONG WAVELENGTH DISTURBANCES IN A PLASMA. Richard L. Liboff (New York Univ., New York). Dissertation Abstr., 23: 657 (Aug. 1962).

The long wavelength modes of excitation of a two component plasma in a steady magnetic field are examined. Two linearized Boltzmann equations are given with collision terms which are coupled through the difference in temperatures and difference in velocities of the two gases. A formal means of classification of phenomena is described in terms of the nature of the roots about $k = 0$. Two types of behavior are uncovered: MHD, magnetohydrodynamics, which include finite phase speed phenomena near $k = 0$; and PEM, plasma electromagnetics, which includes infinite phase speed phenomena near $k = 0$. The dissipative effects of collisions are included. In the limit of vanishing collision frequency, roots previously obtained are recaptured. The relevance of the pertinent domains are discussed and the complex interplay between the fast and Alfvén modes of MHD and the plasma-magnetic modes of PEM is demonstrated. Equations macroscopic in appearance are derived which include the effects of the initial configuration. In the limit of large collision frequency the equations reduce to standard forms. The dispersion of the N^{th} order Larmor

resonance is given which includes the effect of the mass ratio. A discussion of the transfer equations of a plasma is included.

33945 RADIAL DISTRIBUTION OF A POSITIVE, PLASMA DISCHARGE IN A MAGNETIC FIELD. L. L. Artsimovich and A. V. Nedospasov. Dokl. Akad. Nauk SSSR, 145: 1022-4(Aug. 11, 1962). (In Russian)

A positive plasma discharge becomes unstable on applying a longitudinal magnetic field exceeding a certain critical strength H_c. With $H \gg H_c$ the motion of the plasma becomes turbulent in character. The middle 80 cm length of a 150 cm long tube (55 mm in diameter) was put in a variable magnetic field of up to 1500 oe. A spherical platinum probe (1.35 mm in diameter), which was movable along the cross section of the tube, and two cylindrical probes at a distance of 45 cm from each other were used to measure the longitudinal field $E_{||}$. The thermocathode was placed at a distance of 50 cm from the edge of the solenoid. The movable probe was put at a distance of 42 cm from the front face of the solenoid. The measurements were carried out in helium at a current of 0.5 amperes. The electric field $E_{||}$ is plotted as a function of H for $p = 2 \times 10^{-2}$ mm Hg std. The radial distribution of the plasma density n(r) is given as a function of the radial distance r at a pressure of 2×10^{-1} mm Hg std with H = 1500 oe and H = 0. The density distribution n(r) at $H = H_c$ is the same as that obtained theoretically for classical diffusion. At $H \cong 3 H_c$, movement of electrons takes place due to turbulent convection, and $E_{||}$ is close to saturation. (TTT)

33946 MICROWAVE MEASUREMENTS OF STEADY-STATE AND DECAYING PLASMAS. Perry W. Kuhns (National Aeronautics and Space Administration, Cleveland). IRE (Inst. Radio Engrs.), Trans. Space Electron. Telemetry, SET-8: 173-8(June 1962).

Some results are given of an experimental study of the loss mechanism for electrons in plasmas. Steady-state and decaying plasmas were studied by means of microwave interferometers. Values of the electron-ion recombination coefficient for nitrogen and argon are given. The effect of water vapor as an impurity upon the electron-ion recombination rate of air is demonstrated. Data are also given on the transmission of microwave through an ionized layer about a body in a supersonic gas stream and the effect upon transmission of water vapor addition to the stream. (auth)

33947 SWIRLS PRODUCED IN A "CROWBARRED" ROTATING PLASMA. John M. Wilcox, William S. Cooper, III, Alan W. DeSilva, George R. Spillman, and Forrest I. Boley (Univ. of California, Berkeley). J. Appl. Phys., 33: 2714-15(Sept. 1962). (UCRL-10010)

Hydromagnetic swirls develop in a rotating gaseous plasma subjected to an electromagnetic braking action. Observations of these swirls, and the effect of a conducting grid upon them, are discussed. (auth)

33948 VELOCITY OF PROPAGATION AND NATURE OF LUMINOSITY FLUCTUATIONS IN A PLASMA JET. Mark P. Freeman (American Cyanamid Co., Stamford, Conn.), Sik U. Li, and W. Von Jaskowsky. J. Appl. Phys., 33: 2845-8(Sept. 1962).

The velocity of propagation of the luminous detail in a plasma jet is determined by the time required for transit between photomultiplier stations at different axial positions of an expanded plasma jet. The measurements are synchronized with power supply ripple to eliminate this ripple as a random perturbation. It is found that the luminous fluctuations travel at two velocities. Slow fluctuations move with nearly the calculated speed of the jet and may therefore be ascribed to temperature or possibly composition fluctuations, while much faster fluctuations travel with jet speed plus local sonic velocity and are evidently pressure waves. (auth)

33949 SOURCES OF ERROR IN THE MICROWAVE DIAGNOSTICS OF PLASMAS. R. Warder, M. Brodwin, and Ali Bulent Cambel (Northwestern Univ., Evanston, Ill.). J. Appl. Phys., 33: 2868-70(Sept. 1962).

Errors in the microwave diagnostics of plasmas are investigated, using dielectric and conducting models. The results indicate that plasma-property measurements utilizing reflection and transmission techniques are in considerable error for small samples, and that planar analysis cannot be used to infer the properties of a cylindrical plasma. (auth)

33950 POLARIZING EFFECT IN NONLINEAR PLASMA INTERACTIONS. Leonard S. Taylor (General Electric Space Sciences Lab., Valley Forge, Penna.). J. Appl. Phys., 33: 2913-14(Sept. 1962).

A plasma is considered that has an applied electric field that oscillates sinusoidally with a frequency ω_1. The propagation of an electromagnetic wave of frequency ω_2 (assuming $\omega_2 \gg \omega_1$) through this plasma is studied. The dielectric constant of the plasma is found as a function of ω_2 and of the plasma-gas properties. It is found that the effect of the field having frequency ω_1 is to produce sidebands of the propagated wave at frequencies $\omega_2 \pm \omega_1$, $\omega_2 \pm 2\,\omega_1$, etc. (T.F.H.)

33951 SPHERICAL LANGMUIR PROBE IN "DRIFTING" AND "ACCELERATED" MAXWELLIAN DISTRIBUTION. G. Medicus (Advanced Techniques Branch, Wright-Patterson AFB, Ohio). J. Appl. Phys., 33: 3094-3100(Oct. 1962).

The treatment of the "accelerated half-Maxwellian" (AM), essentially according to Langmuir's probe theory for spherical probes, is supplemented by that of the Maxwellian with superimposed drift (DM). The differences between the two cases are characterized. As far as the energy spectra are concerned, the difference is as follows: in the DM at least an infinitesimal number of carriers that happen to fly exactly against the drift have zero energy, whereas in the AM there are no carriers with energies smaller than that corresponding to acceleration voltage. The energy spectrum in the AM, therefore, is zero between zero and acceleration energy, with an abrupt rise at the latter energy. The energy spectrum in the DM is zero only at zero energy, with a smooth rise to a maximum. Differences in the ionic properties are as follows: in the AM, carriers of opposite sign are accelerated in opposite directions and the acceleration energies are proportional to the charges of the carriers, whereas in the DM the drift energy is proportional to the masses of the carriers, which all drift in the same direction. Therefore the ion probe current in the DM at large enough drift velocities is as significant as the electron probe current, whereas in the AM the ion probe current retains its secondary role, which is essentially determined by $(m_e/m_i)^{1/2}$, (m_e = electron mass, m_i = ion mass). The second derivatives of the probe currents with respect to the probe voltage show clearly the significant differences between the two cases. Typical examples are plotted. (auth)

33952 DYNAMIC LANGMUIR PROBE STUDIES. R. W. Carlson, T. Okuda, and H. J. Oskam (Univ. of Minnesota, Minneapolis). J. Appl. Phys., 33: 3141-2(Oct. 1962).

The effects of circuit parameters, probe configuration, current delays, and displacement-current spikes on the results obtained using dynamic Langmuir probe methods are outlined. The analysis of these effects is carried out

in the positive column of a d-c discharge, using pulsed-probe, high-frequency-probe, resonance-probe, and fixed-probe-time-varying-plasma measuring methods. (T.F.H.)

33953 INTERACTION OF H.F. ELECTROMAGNETIC FIELD WITH PLASMA CYLINDER. Stefan Chwaszczewski. Nukleonika, 7: 369-77(1962). (In Polish)

The interaction of a high-frequency electromagnetic field with a long plasma cylinder is considered. Using an analog computer, the distribution of electric and magnetic fields along cylinder radius by formation of a skin layer is solved. (auth)

33954 LANDAU DAMPING AND RESONANT ENERGY ABSORPTION. Ching-Sheng Wu (California Inst. of Tech., Pasadena). Phys. Rev., 127: 1419-22(Sept. 1, 1962).

A physical interpretation of the Landau damping is given based on the Vlasov equations. It is shown that the Landau formulation and a certain calculation of resonant energy absorption are equivalent. It is also found possible to compare the analysis based on the Vlasov equations to an intuitive formulation. (auth)

33955 KINETIC EQUATION FOR PLASMA. H. W. Wyld, Jr. and D. Pines (Univ. of Illinois, Urbana). Phys. Rev., 127: 1851-5(Sept. 15, 1962).

The collision integral for the kinetic equation describing a quantum mechanical plasma is set up. It is shown that the classical collision integral is easily obtained from the quantum mechanical result by letting $\hbar \to 0$. The kinetic equations that describe the interactions of the electrons with plasma oscillations are obtained by isolating the contributions from the plasma oscillations. (auth)

33956 MICROWAVE STUDIES OF A PULSED GLOW DISCHARGE. C. W. Davidson and W. E. J. Farvis (Univ. of Edinburgh). Phys. Rev., 127: 1858-64(Sept. 15, 1962).

An investigation of the behavior of a pulsed glow discharge in helium is made using a microwave method (3kMc) supplemented by light intensity and spectroscopic measurements. The discharge tube is mounted across a section of rectangular waveguide, parallel to the electric field vector of the TE_{10} mode. Time-resolved microwave admittance measurements and dielectric post theory are used to determine the variation in parameters for the section of the discharge within the waveguide. The method is particularly suitable for high electron densities, and resolutions of 1 cm along the axis of the discharge and 1 μsec in time can be obtained without difficulty. The variation in discharge parameters is studied when rectangular current pulses of a few milliamperes are superimposed on a small d-c maintaining current. A low pulse-repetition frequency is used and the admittance measurements are recorded photographically in order to minimize changes in discharge characteristics and to extend the useful life of the discharge tubes. Sufficient results are obtained to give a qualitative picture of the behavior of a glow discharge under transient conditions, and a recombination coefficient for helium of approximately 10^{-6} cm^3/ion sec is measured during the afterglow period. This result is in agreement with results obtained by other microwave methods. (auth)

33957 CONCERNING THE STRUCTURE OF MAGNETOHYDRODYNAMICAL SHOCK WAVES IN A GAS WITH ANISOTROPIC CONDUCTIVITY. A. G. Kulikovskii and G. A. Lyubimov. Priklad. Mat. i Mekhan., 26: 791-2(July-Aug. 1962). (In Russian)

The structure of magnetohydrodynamic shock waves was examined in the medium of a gas with anisotropic conductivity. Use was made of the generalized form of Ohm's law, and the problem was examined for a one-dimensional stationary flow. The behavior of the shock wave width was determined for various limits of the dissipation coefficients. Thus if one of the coefficients goes to zero while the other remains finite then the width of the shock wave approaches infinity. Then for any finite interval the solution of the problem tends to become periodic and the entropy does not increase. Such a solution can be looked upon as a macroscopic analog of the solution for a plasma with no dissipation. (TTT)

33958 SHEET PLASMA DEVICE. Oscar A. Anderson. U. S. Patent 3,044,945. July 17, 1962.

An ion-electron plasma heating apparatus of the pinch tube class is designed wherein a plasma is formed by an intense arc discharge through a gas and is radially constricted by the magnetic field of the discharge. To avoid kink and interchange instabilities which can disrupt a conventional arc shortly after it is formed, a pinch tube has a flat configuration for forming a sheet of plasma between two conductive plates disposed parallel and adjacent to the plasma sheet. Kink instabilities are suppressed by image currents induced in the conductive plates while the interchange instabilities are neutrally stable because of the flat plasma configuration wherein such instabilities may occur but do not dynamically increase in amplitude. (AEC)

Shielding

33959 (FZK-144) A STUDY OF SPACE RADIATION SHIELDING PROBLEMS FOR MANNED VEHICLES. R. K. Wilson, R. A. Miller, and R. L. Kloster (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). June 8, 1962. Contract NAS5-1093. 204p.

The resolution of the problem of protecting space vehicle crews from charged particles of either solar-flare or trapped-radiation origin will probably depend on shielding. The basic problem is concerned with determining quantitatively the attenuation requirement of the incident radiation and selecting an appropriate material to provide this shielding. The hazards of space radiation, the methods of dose calculation, and the development of a proton penetration procedure are discussed. A summary of cross section data and the results of shielding calculations with particular emphasis on contributions to the dose from secondary radiation are also included. (auth)

33960 A NOTE ON THE SHIELDING OF ENERGETIC PARTICLES IN SPACE. S. P. Shen (State Univ. of New York, Albany). Astronaut. Acta, 8: 228-31(1962). (In English)

The role of inelastic nuclear interactions in the shielding of space vehicles against cosmic rays is discussed. Some existing experimental and theoretical data of interest are suggested. (auth)

33961 ENERGY LOSS AND RANGE OF α PARTICLES IN BORON IN THE ENERGY RANGE FROM 0.2 TO 5.3 Mev. D. Kamke and P. Kramer (Universität, Marburg, Ger.). Z. Physik, 168: 465-73(1962). (In German)

With a scintillation spectrometer the air equivalent of boron for α particles was measured as a function of energy. The boron foils (50 to 120 $\mu g \cdot cm^{-2}$) were evaporated onto thin mica. The α-particle energy was set between 0.2 and 5.3 Mev by letting the particles of a Po^{210} α source pass through air. With known data for the energy loss in air, the range and stopping power in boron were determined. The error of each measured datum is about 2%. (auth)

Theoretical Physics

33962 NOTE ON THE BLATT-BIEDENHARN FORMALISM. C. P. Sikkema (Rijks Universiteit, Groningen, Netherlands). Nucl. Phys., 37: 526-8(Sept. 1962). (In English)

A simplified version is given of differential cross section formulas, as applied to resonances in reactions or elastic scattering. This version is useful for practical calculations if the resonances proceed with more than one channel spin in the entrance or exit channels. (auth)

33963 SOLUTIONS OF EINSTEIN'S FIELD EQUATIONS I AND II (SINGULAR CASES). Kaushik Chandra Shekhar (Asfa Wosen School, Addis Ababa, Ethiopia). Nuovo Cimento (10), 25: 1204-26(Sept. 16, 1962). (In English)

The solution of Einstein's first set of field equations is considered, for the first and second classes of space-time, in the singular cases for all possible indices of inertia. (auth)

33964 GRAPH THEORY AND PARAMETRIC REPRESENTATIONS OF FEYNMAN AMPLITUDES. Y. Shimamoto (Brookhaven National Lab., Upton, N. Y.). Nuovo Cimento (10), 25: 1292-1313(Sept. 16, 1962). (BNL-5702). (In English)

Elementary graph-theoretic properties of connected Feynman diagrams are used to derive a topological formula, which permits the parametric integrals of an arbitrary Feynman amplitude to be written down by inspection, in terms of the external momenta. Several examples are given and two theorems on normal thresholds are discussed. (auth)

33965 ELEMENTARY REMARKS ON THE ANGULAR MOMENTUM DEFINITION FOR UNSTABLE SYSTEMS. E. G. Beltrametti (Università, Genoa and Istituto Nazionale di Fisica Nucleare, Genoa). Nuovo Cimento (10), 25: 1393-7(Sept. 16, 1962). (In English)

The spin and angular momentum of short-lived unstable particles are discussed. It is suggested that the uncertainty principle precludes the existence of a sharply defined angular momentum or spin for such particles. (T.F.H.)

33966 SINGULARITIES OF THE FIVE-POINT FUNCTION IN PERTURBATION THEORY. Francis R. Halpern (Univ. of California, San Diego, La Jolla). Phys. Rev., 127: 1819-20(Sept. 1, 1962).

A rational parametrization of the leading portion of the Landau manifold for the five-point function is developed. The parameters chosen are the integration parameters. If these parameters satisfy a normalization condition, then the physical-sheet singularities are found when all the signs of the real part of all the parameters are the same. (auth)

33967 QUANTIZATION OF THE YANG-MILLS FIELD. R. L. Arnowitt and S. I. Fickler (Syracuse Univ., N. Y.). Phys. Rev., 127: 1821-9(Sept. 1, 1962).

The Yang-Mills field, a gauge-type nonlinear field which lies between electrodynamics and general relativity in complexity is examined. The quantum Yang-Mills field is introduced to satisfy the requirement of invariance under isotopic phase transformations of the second kind. The theory is then put into its first-order form, so as to make it amenable to quantization by the methods of the Schwinger action principle. Quantization is carried out for the two different gauge conditions; the first (the analog of the radiation gauge in electrodynamics) leads to a perturbation treatment of the constraints of the theory, and the second to a rigorous solution of the constraints. Two conditions for a consistent quantization are investigated. These are: the requirement that the Lagrange equations be identical to the Heisenberg equations of motion (the latter being evaluated using the field commutation relations); and the requirement that the constraint equations be conserved in time (which leads to a condition on double commutators in the q-number theory). In the radiation gauge, these conditions are shown to be satisfied in lowest-order perturbation theory. In the second gauge used, they are rigorously satisfied. It is also shown for this second gauge that the field Hamiltonian is positive definite when coupling to fermion isotopic currents is ignored. No investigation of consistency conditions arising from Lorentz covariance requirements is made. (auth)

33968 COMPLEX ANGULAR MOMENTUM IN FIELD THEORY. K. Bardakci (Univ. of Minnesota, Minneapolis). Phys. Rev., 127: 1832-6(Sept. 1, 1962).

The notion of complex angular momentum is extended to relativistic scattering amplitudes satisfying the Mandelstam representation. The domain of analyticity in the complex angular momentum plane is enlarged by the use of unitarity relations, and the existence of Regge poles in a certain restricted domain is established. (auth)

33969 INTEGRAL REPRESENTATION FOR A SCATTERING AMPLITUDE WITH COMPLEX SINGULARITIES. Christian Fronsdal, Kalyana Mahanthappa, and Richard Norton (Univ. of California, Los Angeles). Phys. Rev., 127: 1847-50(Sept. 1, 1962.)

A double integral representation for a scattering amplitude, which includes the contribution of a box diagram with complex singularities, is obtained. The integrations extend over real values of energy and momentum transfer only. (auth)

REACTOR TECHNOLOGY

General and Miscellaneous

Refer also to abstracts 33468 and 33577.

33970 (AAEC/E-91) HIGH ENERGY NEUTRON SPECTRA IN INFINITE HOMOGENEOUS REACTOR SYSTEMS MODERATED BY BERYLLIUM OR BERYLLIA. A. Keane and R. G. Mills (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). July 1962. 16p.

A program is described for determining the neutron enhancement due to the (n,2n) reaction in reactor systems moderated by beryllium. For moderation by pure beryllium the enhancement was found to be 9.7%. (auth)

33971 (AEEW-R-69) THE TRANSMISSION OF FAST NEUTRONS ALONG AIR FILLED DUCTS IN WATER. D. C. Piercey and D. E. Bendall (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). June 1962. 34p.

Measurements of fast flux, by means of the $S^{32}(n,p)P^{32}$ reaction, were made along air filled ducts in the water of the LIDO Panel C facility. Using results obtained by the method of moments, a technique was devised for predicting the absolute sulfur reaction rate to better than a factor of 2 for ducts of up to 200 duct radii in length. (auth)

33972 (AEEW-R-166) MEASUREMENT OF THE FISSION RATIO FOR SEVERAL CONFIGURATIONS OF URANIUM OXIDE ROD CLUSTERS. S. K. Pattenden and C. R. Patterson (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Feb. 14, 1962. 33p.

Measurements of the fission ratio for a single fuel channel of oxide rod clusters in an essentially infinite block of graphite are described. The measurements were made using catcher-foils, the activities of which were measured by β-counting. Results are given for 37-rod, 18-rod, 7-rod, and 3-rod clusters. The results are compared with theoretical predictions. (auth)

33973 (ANL-6601) CALCULATIONS OF THE DOPPLER COEFFICIENT OF LARGE CERAMIC-FUELED FAST REACTORS. M. G. Bhide and H. H. Hummel (Argonne National Lab., Ill.). Aug. 1962. Contract W-31-109-eng-38. 23p.

Calculations of the Doppler coefficient of large, ceramic-fueled fast reactors containing plutonium were made by means of the ELMOE program to provide accurate flux calculations. The temperature-dependent cross sections of P. Greebler et al., for U^{238} and Pu^{239} were used. Doppler coefficients of the order of 10^{-5} δk/°C were obtained, in agreement with Greebler's results. Coefficients of carbide fueled reactors are about 0.7 of those of oxide-fueled reactors at the same fuel enrichment. Effective coarse-group elastic-removal cross sections for light elements are tabulated. It appears that, with tabulations of this sort as a guide, coarse-group sets of cross sections can be constructed to give adequate accuracy in calculations of Doppler coefficients without use of ELMOE. (auth)

33974 (ANL-6610) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, AUGUST 1962. (Argonne National Lab., Ill.). Sept. 15, 1962. Contract W-31-109-eng-38. 78p.

Technical progress is reported on specific reactor projects and on general engineering research and development programs. Developmental activities are reported on the EBWR, Borax-V, the liquid metal cooled zero power experiments, EBR-I, EBR II, and FARET. In general reactor technology, research is reported on applied reactor physics, reactor fuels development, reactor materials, and chemical separations. In advanced systems research and development, work is reported on the Argonne Advanced Research Reactor and on direct conversion. Safety studies are reported on thermal reactors and fast reactors. (J.R.D.)

33975 (ANL-6619) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, SEPTEMBER 1962. (Argonne National Lab., Ill.). Oct. 15, 1962. Contract W-31-109-eng-38. 69p.

Progress is reported on development of liquid metal and water cooled reactors. Details are included concerning the EBWR, Borax V, ZPR-III, ZPR-VI, AFSR, EBR-I, EBR-II, and FARET. Developments in general reactor technology are reported in applied reactor physics, reactor fuel and components development, heat engineering, and chemical separations. Advanced systems research and development was devoted to the Argonne Advanced Research Reactor and a conduction-cooled reactor to substitute for isotope heat sources. Safety studies are reported on thermal and fast reactors. (J.R.D.)

33976 (ARF-8262-2) STUDIES OF REACTOR CONTAINMENT STRUCTURES. Bi-Monthly Progress Report, July–August 1962. N. A. Weil, R. L. Chiapetta, C. J. Constantino, P. G. Hodge, S. A. Morse, and M. A. Salmon (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Sept. 14, 1962. Contract AT(11-1)-578. 60p.

Analyses are being made of the response of containment vessels. Approximate burst strengths of finite cylinders with various end conditions were determined. The behavior of the infinite cylindrical shell under dynamic loads was studied. The effects of openings on the strength of vessels are being investigated. The effects of a central rigid insert on the strength of a flat circular membrane were determined. Materials are being fabricated for bulging experiments on pressurized cylinders of finite length. A containment handbook is being prepared. (M.C.G.)

33977 (BAW-1259) SPECTRAL SHIFT CONTROL REACTOR—BASIC PHYSICS PROGRAM. Quarterly Technical Report No. 7, April–June 1962. (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). Contract AT(30-1)-2602. 77p.

Work performed on the Spectral Shift Control Reactor Basic Physics Program is summarized. The major objective of this program is to study the nuclear properties of slightly enriched lattices moderated by D_2O-H_2O mixtures. Critical experiments were performed with 4%-enriched UO_2 fuel rods in a lattice having a non-moderator-to-moderator volume ratio of 1.2, and moderated by a 49.7% D_2O-H_2O mixture. Measured were critical mass, $d\rho/dh$, buckling and reflector savings, and cadmium ratios of U^{235} and U^{238}. Small systematic errors in the cadmium ratios were evaluated by correlating the measurements over a range of moderator compositions from zero to 70.1% D_2O. The critical parameters of the first assembly with 2.46%-enriched UO_2 fuel rods are reported. The lattice had a non-moderator-to-moderator volume ratio of 1.0, and was moderated by light water. Physical and chemical properties of the 2.46%-enriched fuel are summarized. The objectives, conceptual design, and final design details of the

small lattice experiments are given. These experiments will test the applicability of the PCTR technique to lattice measurements in epithermal systems. Also presented are improvements to the BPG code: a neutron source is now permitted in each group and a standard set of thermal cross sectional data is incorporated. Previous analytical methods were used to check the most recent critical experiment data. The results of a systematic analysis of other light water moderated systems, using methods developed for D_2O-H_2O moderated lattices, are summarized. Design calculations for the small lattice experiments and the reactivity-period relation for critical assemblies using 2.46%-enriched UO_2 fuel are given. (auth)

33978 (BMI-X-10008) A STUDY OF ROTARY SHAFT-SEALING CONCEPTS FOR PRESSURIZED-WATER REACTOR APPLICATION. Quarterly Progress Report, April–June 1962. C. M. Allen (Battelle Memorial Inst., Columbus, Ohio). July 1, 1962. Work performed under United States–Euratom Joint Research and Development Program. Contract W-7405-eng-92. 15p. (EURAEC-423)

Activities in a program to develop basic principles of seal operation for application in pressurized water reactors are reported. The effort during the report period was devoted to assembling and evaluating information for use in planning an experimental program. Details of a preliminary research plan are included. (J.R.D.)

33979 (EURAEC-276) HEAT TRANSFER AND STABILITY STUDIES IN BOILING WATER REACTOR. Quarterly Progress Reports III and IV, July 1, 1961 to January 1, 1962. (Eindhoven, Netherlands. Technische Hogeschool). Jan. 1962. Work performed under United States–Euratom Joint Research and Development Program. Contract 032-60-11RDH. 39p. (WW/R-9)

Experiments performed with a model of the first core loading of the Halden reactor were worked out. Slip factors and two-phase friction factors were determined and compared with the results of other investigations. Also nonboiling lengths, exit void-fraction and steam qualities were calculated. The results were compared with theoretical calculations. Some calibrations and cold tests were carried out. The development of a fast differential pressure gauge for detecting flow instabilities, was successful. Some measurements, concerning the control characteristics of the rectifier-unit, were carried out. It seems that a fluctuation up to about 8 Hz. can be excited with amplitudes of 10 to 30% of average power. In one series of tests a glass shroud was used with open ends, while the heat flux had a stepwise distribution. The void fraction and circulation rate were measured as a function of pressure up to 30 atmosphere and of power up to 150 kilowatt. It appeared that the maximum flow rate for constant temperatures occurred at power readings of about 20 to 30 kilowatt, thus at a much lower power than that previously obtained with an aluminum shroud with inlet holes in the hull. Also, the slope of the circulation rate versus the power curve beyond the maximum flow rate was much more negative. Experiments were made at high heat fluxes for clearing the Halden Boiling Water Reactor for operation at 10 megawatt and 30 atmosphere. These experiments were carried out with the single rod test section with aluminum shroud as used previously at three temperatures: 140, 200, and 230°C. Burnout was not obtained in the tests. A heat flux of 220 watt/cm^2 was safely transmitted to water at 30 atmosphere pressure (230°C saturation temperature), 115 cm/sec channel inlet velocity, 5.7% steam quality at the exit and 1.7 to 3.9% at the position of maximum heat flux. In these experiments a qualitative measurement was made of the void fraction using a capacitative gauge at 90% of the channel height. It was observed that the mean deflection on the oscilloscope increased with channel power. The oscillations present in the void fraction signal were recorded. There was some indication of hydraulic instability in the region of high power. Use was made in tests of a rod cluster element simulating a second core loading fuel channel of the Halden Boiling Water Reactor. The purpose of these tests was to demonstrate that the flow conditions in the reactor at 10 megawatt and 30 atmosphere were stable. These tests were carried out at the same temperatures as the others. Recordings were made of void fraction and flow rate using capacitative gauges. It was concluded that beyond the maximum flow rate the oscillations observed were larger than for the model of the first core loading fuel channel. Also, the pressure drop across the inlet holes was considerably higher. The absolute and differential pressure gauges and the void gauge using capacitative methods were further developed. They were used in the pressurized boiling loop up to 230°C. A theoretical study was made concerning the possibilities of an accoustical method for the determination of void fraction and bubble dimension. A study was started to investigate in detail the measuring and recording technique for noise and oscillation of low frequencies and the analysis of such signals to supply data from which transfer functions can be obtained. (auth)

33980 (EURAEC-332) DEVELOPMENT PROGRAM ON THE APPLICATION OF STEAM-WATER SPRAY TO REACTOR COOLING. CAN-3 Quarterly Progress Report No. 2, April 1 to June 30, 1962. (Centro Informazioni Studi Esperienze, Milan). July 1962. Work performed under United States–Euratom Joint Research and Development Program. Contract 056-62-1RDI. 14p. (CISE-R-61)

Work is in progress in order to modify the existing heat-transfer and hydrodynamics facility and the associated auxiliaries. The design of the electrical power supply system to the test elements was almost completed along with the design of the flow rate, pressure, and electric power measuring systems. While the boiler maintenance and repair is in progress, different components of equipment to be assembled in Genoa are being manufactured. Preliminary in-pile experiments on gas removal from water were completed. Analytical methods for hydrogen and oxygen determination in water samples are being set up and filters for crud removal are being tested. Fast neutron flux measurements in unperturbed conditions were completed. Experiments were also carried out on radiation streaming along the channel, which led to some modification in the test section design. Tests on pressure shock resistance of the test section containment tube had to be postponed due to some delay in components delivery. (auth)

33981 (GEAP-3937) AN ANALYSIS OF METHODS IN CONTROL ROD THEORY AND COMPARISONS WITH EXPERIMENT. G. H. Kear and M. H. Ruderman (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). May 27, 1962. Contract AT(04-3)-189. 84p.

The theory of control in reactors is discussed. A method for replacing transport theory by an equivalent diffusion theory is discussed. Boundary conditions on pure absorbers in a diffusion theory medium are developed for various geometries. Available methods are used to calculate control worth. The results are compared with an extensive set of measured values of worth and the degree of accuracy of the calculated values is exhibited. In this comparison a

variety of control element types in a variety of reactor lattices is considered. (auth)

33982 (GEMP-74) REACTOR INSTRUMENTATION AND CONTROL PROGRESS REPORT NO. 74. [John Blake] (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Sept. 28, 1962. Contract AT(40-1)-2847. 47p.

A valve was designed for use with the mechanical drive ball for circulating-ball reactivity control, which will permit selective operation between the shim and scram function. The requirements for an electromagnetic drive capable of higher temperature operation were investigated, and a prototype unit was fabricated. A variable-reluctance sensor was constructed and tested. A five-channel trip circuit was constructed and used to control a pneumatic valve, and environmental temperature testing was conducted. Beryllia samples of various grain sizes, densities, and purities were tested as temperature sensors to compare the effects of these parameters. An alumina sensor with molybdenum electrodes was assembled and several yttria sensor specimens were fabricated. Fission counters were tested for operation at 1500°F. Ionization chambers were also tested for high-temperature operation. Studies were made on designs for future a-c ionization chambers by using analog techniques. An amplifier system was built, and work was begun on a high-temperature chamber. (M.C.G.)

33983 (HW-61151) TRITIUM GENERATION IN D_2O SYSTEMS OF PRTR. J. J. Regimbal and W. H. Hayward (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 20, 1959. Contract [AT(45-1)-1350]. 19p.

The tritium concentration in the D_2O systems of the PRTR were calculated as a function of time. The tritium build-up in the coolant, moderator, and reflector systems was determined for the following leakage situations: no leakage; normal leakage rates in moderator and coolant systems with replenishment with unirradiated D_2O; and normal leakage rate for coolant system with replenishment with irradiated D_2O from the moderator system. Results of the analyses are shown graphically. (M.C.G.)

33984 (INTERNUC-67) MIST (MULTIGROUP INTERNUCLEAR SLAB TRANSPORT). G. E. Putnam and D. M. Shapiro (Internuclear Co., Inc., Clayton, Mo.). Aug. 18, 1961, First printing; Oct. 12, 1961, Second printing. For Phillips Petroleum Co., Atomic Energy Div., Idaho Falls, Idaho). Contract AT(10-1)-205. Subcontract C-222. 105p.

A description is given of a set of codes designed to solve the one-dimensional Boltzmann equation in slab geometry for up to six energy groups, two hundred and fifty space points and forty regions. The boundary conditions for each group can be independently specified and the boundary conditions permit very general specifications with regard to: perfect mirror reflection or symmetry, anisotropic diffuse sources (by input of Legendre polynomial coefficients or a short table describing a known angular distribution of the flux), and isotropic (Lambert surface) reflection. Independent specification of an isotropic volume source in each group is also allowed. Although scattering from one group to another is assumed to be isotropic, the scattering function within each group can be a second order Legendre polynomial series. The method used to solve for the angular dependent flux in each group is not iterative; hence, few group problems require no more than a few outer iterations. The numerical approximation to the Boltzmann equation is a linear one which can be described as an extension and generalization of methods used in the original Sn codes. The physically unrealistic non-symmetrical nature of the former Sn approximation in slab cases with regard to fluxes in the forward and backward hemispheres was removed. The MIST program is the first application of the new formulation with a non-iterative method of solution for the fluxes in each energy group of a slab geometry model. The coupling of the groups is by way of downscattering and fission. The program is divided into four separate codes in order to provide the maximum number of space points for each order of the angular approximation. The limits on the number of mesh points in each code are given. The MIST program is presently written for an IBM 7090 with 32K storage. It is in the FORTRAN language which allows for relatively easy modification and adaptation to other computing systems. (auth)

33985 (LAMS-2753) QUARTERLY STATUS REPORT ON LAMPRE PROGRAM FOR PERIOD ENDING AUGUST 20, 1962. (Los Alamos Scientific Lab., N. Mex.). Sept. 1962. Contract W-7405-eng-36. 18p.

Operation of the Lampre I during the report period is described and data on the operating history of this reactor are summarized. Other work is reported on core calculations, fuel and container development, and compatibility of Pu-Co-Ce alloys with Ta. Studies of the physical properties of Pu alloys with C, In, Si, and rare earths are described. Data on the room temperature densities in the Pu-Ce-Co alloy system are presented. Solvent extraction studies concerning separation of Pu are included along with results of electrorefining of irradiated Pu fuels. The developmental status of the core test facility is reported. (J.R.D.)

33986 (NASA-TN-D-1460) EXPERIMENTAL NEUTRON FLUX DISTRIBUTIONS IN A GRAPHITE ASSEMBLY WITH AN INTERNAL CAVITY. Thomas A. Fox, Donald F. Shook, Robert A. Mueller, and Daniel Fieno (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). July 18, 1962. 27p.

A modified graphite assembly containing a cavity region and a Po-Be neutron source at its geometrical center was used to study neutron diffusion in a simulated cavity reactor configuration. Experimentally determined relative neutron flux distributions from bare and Cd-covered In activities are presented for a BF_3-gas-filled cavity case to simulate UF_6 absorption characteristics, an air-filled (void) cavity case, and a solid-graphite case for a standard. An 18-group diffusion analysis of the BF_3 cavity case was made, and the results are compared with the experimental case. (auth)

33987 (NP-12059) ON A DIRECT AND INTUITIVE METHOD FOR THE DERIVATION OF THE RELATION BETWEEN k_∞ AND k_{eff}, AND ITS GENERALIZATION TO MEDIA WITH REFLECTOR. Ahmed Yueksel Oezemre (Turkey. Atomic Energy Commission. Çekmece Nuclear Research Center, Istanbul). 1962. 7p. (CNAM-1)

The relation between the effective and infinite multiplication factor is deduced, comparing simply the neutron contents of a finite medium with that of an infinite medium. The extension of this comparison to the case of a reflected medium makes it possible to establish a similar relation where the albedo of the reflector plays an important role. From this relation, the reactivity saving of a reflected medium, which may be defined as the relative increase of the effective multiplication factor of the medium when it is surrounded with a reflector, can be easily evaluated. (auth)

33988 (NRL-5630) THE PRESENT STATUS OF CHEMICAL RESEARCH IN ATMOSPHERE PURIFICATION AND CONTROL ON NUCLEAR-POWERED SUBMARINES.

Annual Progress Report. V. R. Piatt and E. A. Ramskill, eds. (Naval Research Lab., Washington, D. C.). July 14, 1961. 134p. (AD-260235)

Research on submarine air-replenishment equipment is reported. Oxygen sources, carbon dioxide removal, atmosphere sampling and analysis, and elimination of contaminants are discussed. (M.C.G.)

33989 (SRO-72) HEAVY WATER POWER REACTOR PROGRAM MONTHLY PROGRESS REPORT, AUGUST 1962. (Savannah River Operations Office, AEC). 11p.

Research and development progress is reported on the AEC-AECL cooperative program, header and feeder piping fluid dynamics, zirconium technology, development of sintered aluminum products, heat transfer at low heat flux, irradiation programs, Vallecitos Boiling Water Reactor, Savannah River Components Test Reactor, and Carolinas-Virginia Tube Reactor. (M.C.G.)

33990 (TID-7634) PROCEEDINGS OF THE NUCLEAR SUPERHEAT MEETING—NO. 6, MARCH 7, 8, AND 9, 1962, WINDSOR, CONNECTICUT. Andrew E. Mravca (Chicago Operations Office, AEC). Mar. 30, 1962. 146p. (COO-265)

Minutes of the Nuclear Superheat Meeting, No. 6, are presented. A bibliography of reports published on the superheat program is included. Engineering data obtained in the superheat program are given. Work on the BONUS reactor, the general nuclear superheat (NUSU) reference reactor design, the Pathfinder Reactor, the boiling reactor experiment BORAX-V, the Vallecitos Superheat Reactor, the Mixed Spectrum Superheat Reactor, and other design concepts are discussed. (M.C.G.)

33991 (TID-16733) FOIL DATA THICKNESS CORRECTIONS AS AFFECTED BY SELF-SHIELDING AND FLUX DEPRESSION. George S. Stanford (Argonne National Lab., Ill.). June 1962. Contract [W-31-109-eng-38]. 19p. (UAC-6503; RED-EPM-94)

A method is presented for obtaining matched-foil data from irradiations of unmatched foils, by making use of the first derivative of published flux-perturbation formulas. It is necessary to treat thermal and resonance activation separately. It is shown that non-uniformity in thickness within a given foil is not normally an appreciable source of error, although the area of the foil should be well known. For the special case of 25-micron gold foils, it is shown that, for moderate thickness deviations from foil to foil, it is a good approximation to neglect the thermal flux perturbations and to assume that the foils are very thick to resonance neutrons, resulting in a rather simple weight-correction formula. (auth)

33992 (TID-16805) STUDIES OF THE DOPPLER EFFECT IN LARGE CERAMIC-FUELED FAST REACTORS. H. H. Hummel (Argonne National Lab., Ill.) and M. G. Bhide (India. Atomic Energy Establishment, Trombay). July 1962. Contract [W-31-109-eng-38]. 4p. (UAC-6682)

Calculations were made of the Doppler effect in $Pu^{239}O_2$–$U^{238}O_2$ and $Pu^{239}C$–$U^{238}C$–fueled fast reactors. The ELMOE program was employed to obtain accurate fluxes. The technique employed was to determine a critical buckling at lower temperature and to use this same buckling at higher temperature to determine k_{eff}. The effect was not very sensitive to the presence or absence of sodium, and was not sensitive to rod size over the range studied. (M.C.G.)

33993 (WAPD-BT-26) BETTIS TECHNICAL REVIEW. REACTOR TECHNOLOGY. (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Sept. 1962. Contract AT-11-1-GEN-14 and appropriate NObs- Contracts. 90p.

Developments in reactor technology are reported in 7 papers. Separate abstracts were prepared for each paper. (M.C.G.)

33994 (WAPD-BT-26(p.1-8)) DOPPLER-BROADENED RESONANCE ABSORPTION IN HETEROGENEOUS SYSTEMS CONTAINING SEVERAL RESONANCE MATERIALS FOR A NUMBER OF SLAB AND PARTICLE GEOMETRIES IN WATER. N. R. Candelore and R. C. Gast (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). (WAPD-T-1439)

A method is described for evaluating Doppler-broadened symmetrized resonance absorption in systems which are complex because of geometry or multiplicity of regions and materials. Isotopic self-shielding factors are calculated by an ALTAC-2 program for the Philco-2000 computer. These factors are input parameters to a multigroup slowing-down program to obtain fast spectrum weighted, few-group diffusion theory constants. (auth)

33995 (WAPD-BT-26(p.9-18)) THERMAL EXPANSION OF PWR-2 FUEL PLATES. R. D. Groninger and R. M. Swanson (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

Tests were made to determine which types of oxide fuel plates have adequate clearance volumes between the UO_2 fuel and the Zircaloy cladding. The investigation showed that, for unannealed fuel plates, those which were pack pressure bonded exhibited higher thermal expansion and greater permanent dimensional increase than those which were fabricated by the isostatic bonding process. This behavior leads to the conclusion that pack pressure bonded plates have less clearance volume than isostatic pressure bonded plates. The tests also showed that there is no significant difference in thermal expansion between isostatic and pack pressure bonded plates, or between either type and Zircaloy, when plates have received a beta quench. (auth)

33996 (WAPD-BT-26(p.19-37)) THEORY AND DESIGN OF CANNED RELUCTANCE MOTORS WITH SLIP-ON STATORS AND COLLAPSIBLE ROTORS. D. A. Guerdan (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

A simplified method of calculating torque and radial force for the collapsible-rotor, canned, reluctance motor is presented. The method employs an analog equivalent for the representation of the magnetic system and, by the use of Maxwell's energy equations, allows the designer to calculate the machine by graphical solutions. (auth)

33997 (WAPD-BT-26(p.39-48)) ROTATIONS OF A TUBE SHEET RIM DUE TO THERMAL LOADING. F. J. Loss (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

The tube sheet rim in a heat exchanger is usually assumed to undergo a uniform rotation about its circular axis due to differential thermal expansion. This assumption is refined to more closely approximate the physical situation by considering the rim in two halves joined at the tube lane. Each half is permitted to rotate freely due to a different linear temperature drop, and compatibility is achieved by introducing a moment at the junction of the rim halves. The complete rotations are obtained by superimposing the effects on the linear temperature drop and this moment. Experimental data are given to verify certain portions of the theoretical analysis. (auth)

33998 (WAPD-BT-26(p.49-62)) OPERATION OF THE PRIMARY SYSTEM OF PWR WITHOUT PURIFICATION. W. Lechnick (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

PWR was operated for 1478 EFPH during Core 1, Seed 2 life in an investigation of the effects of reactor operation without purification. Medium-lived soluble fission product activities (principally 20.8-hour I^{133} and 8.05-day I^{131}) increased markedly in the primary coolant and, because of a primary-to-secondary leak, in the steam generator secondary water. Gross nonvolatile coolant activity doubled during this period. However, these temporary increases caused no operational difficulties, and there was no trend in long-lived activity buildup during the test. (auth)

33999 (WAPD-BT-26(p.63-70)) DISSOLUTION AND FUEL DEPLETION ANALYSIS OF PWR CORE 1 BLANKET RODS. D. Macdonald and G. C. Owens (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

Eight blanket fuel rods removed during the second refueling of PWR Core 1 were chemically dissolved and analyzed to determine the concentrations of uranium, plutonium, and Cs^{137} and the isotopic composition of the uranium and plutonium. The modifications to the existing gamma shielding equipment to contain the alpha activities emitted, the procedure for dissolution of the fuel, the analytical methods used, and the fuel depletion data obtained are described. These are the first experimental physics data for natural UO_2 which was irradiated as a blanket in a power reactor. (auth)

34000 (WAPD-BT-26(p.71-90)) A COMPARISON OF WEAR PERFORMANCE OF INCONEL AND TYPE 304 STAINLESS STEEL. S. Petach, W. F. Brindley, and E. Rau (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

Wear performance tests on Inconel were conducted, with type 304 stainless steel used as a basis for comparison. Split pistons of Inconel and type 304 stainless steel were reciprocated against selected cylinder materials for 500,000 cycles. Results of the comparative tests indicated that there is no significant difference in wear performance between Inconel and type 304 stainless steel. (auth)

34001 (Y-1396) EFFECTS OF MAJOR PARAMETERS ON CYCLE EFFICIENCY AND COST FOR A GAS-COOLED REACTOR TURBINE POWER PLANT (thesis). R. V. Miskell (Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.). June 19, 1962. Contract W-7405-eng-26. 132p.

A cycle study was performed on a closed loop Brayton cycle incorporating a gas-cooled nuclear reactor, regeneration, and compressor intercooling. The purpose of the study was to determine the effect of various cycle parameters on efficiency and cost. Regenerator effectiveness, component pressure drops, and mass flow rates were varied to attain various regenerator pumping power to heat removal ratios and total cycle pumping power to heat removal ratios. A total pumping power to heat removal ratio of 0.05 and a regenerator pumping power to heat removal ratio of 0.02 were picked as cycle parameters. Minimum total cost of the cycle was obtained at a regenerator effectiveness of approximately 0.875. At this effectiveness the cycle with helium as the working fluid and a graphite moderated reactor displayed a 0.3 mills per kwh cost advantage over a carbon dioxide cycle with a beryllium oxide reactor. In the range 50 to 150°F helium exhibited a +0.0025 mills per degree variation for cooler and intercooler outlet temperature variation as compared to +0.0038 mills per degree for carbon dioxide. The respective values for turbine inlet temperature variation were −0.0027 mills per degree and −0.0017 mills per degree in the range 1200 to 1500°F. (auth)

34002 (AEC-tr-5309) PRELIMINARY PROPOSAL OF A SODIUM RIG FOR IRRADIATION IN THE ISPRA-1 REACTOR. A. Gerosa and O. Simoni (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratorio Ingegneria e Servomeccanismi Reattori, Ispra). Translated for Oak Ridge National Lab., Tenn. from Report ISR-87. [May 30, 1962]. 19p.

The design of a sodium loop, with natural sodium circulation, was studied in which the test section is a single coaxial tube with a fuel mixture in the space. The power was found to be 25 kw. Calculations were conducted on the possibility of achieving the natural circulation of the cooling sodium for various dimensions of the cooling circuit, but the results were negative. In view of the impossibility of realizing the loop with natural circulation, a solution was considered which provided for the test section to be constituted of a tube of triangular section containing the $NaUO_3$ mixture installed in a capsule. A slow sodium circulation takes place in this tube for the transport of fission products. The test section is geometrically similar to the amount of mixture which is in the elementary lattice unit of the Raptus reactor in which the sodium circulation takes place under the same hydraulic conditions. (M.C.G.)

34003 CALCULATION OF THE NONSTATIONARY TEMPERATURE FIELD IN A REACTOR CHANNEL AND GENERATION OF THERMOELASTIC STRESSES IN THE FUEL ELEMENT CAN. Yu. E. Bagdasarov and O. D. Kazachkovskii. At. Energ. (USSR), 13: 241-9(Sept. 1962). (In Russian)

The transient, nonstationary temperature stresses taking place in fuel element jackets and other structural materials present problems in the design of liquid-metal cooled reactors. These problems were examined using approximation methods, on 2-layer fuel elements cooled by a heat transfer agent flowing in axial direction with a given velocity. The method used made it possible to estimate the non-stationary thermoelastic stresses generated in the can of the fuel element. Although the values obtained were found to be too high, the method is considered useful for calculating fuel element parameters both in the core and in the blanket; it may be applied for determining the temperature field and the thermoelastic stresses generated in the absence of heat production. The method was also found to be applicable to determine the temperature coefficient of the reactivity during kinetic studies of liquid-metal cooled reactors. (TTT)

34004 TRANSIENT DYNAMICS OF REACTORS WITH VARIABLE NEUTRON SOURCES. Gilberto Tisnado Manosalva (Junta de Control de Energia Atomica, Lima). Bol. inform. junta control energia atomica (Peru), 7: No. 39, 59-68(May-June 1962). (In Spanish)

The transient dynamics of reactors excited by a neutron source with arbitrary time variation is studied. A mathematical model is given which gives a relationship between the principle physical parameters of the reactor. Equations are derived which describe the neutron generators, the thermalization of the delayed neutrons, separation of variables, transformation of the density function, Laplacian transformation, convolution of the transference equation, and monoaxial transformation. (J.S.R.)

34005 NUCLEAR REACTORS IN ITALY. Manuel Telleria Marques (Junta de Control de Energia Atomica, Lima and Centro di Studi Nucleairi Enrico Fermi, Milan). Bol. inform. junta control energia atomica (Peru), 7: No. 39, 78-84(May-June 1962). (In Spanish)

The types of Italian reactors include teaching reactors, research reactors, and power reactors. Brief descriptions

are given of the following: Ispra-1, Avogagro RS-1, Cesnef, Constanza, RC-1, AGIP, RTS-1, Latina, Senn, Selni, PRO, and subcritical reactors. The emphasis in the descriptions is on innovations and nuclear engineering changes. (J.S.R.)

34006 OPTIMUM THERMODYNAMICAL CHARACTERISTICS IN REACTOR COOLING. Gergely Bueki (Technical Univ., Budapest). Energia és Atomtech., No. 4, 171-8 (1962).

The optimum temperature of the coolant leaving the reactor is investigated. A formula is deduced for the variation of the thermal efficiency as a function of the temperature of the coolant leaving the reactor, when the average temperature of the coolant is computed as the mean of its temperature on entry and departure on the T–S diagram. According to the relationship obtained, the increase of the thermal efficiency and the heat capacity decreasing on the reduction of the temperature difference will result in an optimum temperature for the coolant leaving the reactor. While in the case of coal fired generators this optimization is not necessary, in the case of atomic reactors when the fuel temperature is maximum the increase of the coolant temperature on leaving the reactor would result in reduction of the amount of heat removed. The amount of heat removable is proportional to the surface transmitting the heat, the coefficient of heat transmission, and to the average difference between the temperatures of the fuel and coolant. The variation of the temperature difference is examined for evaporation cooling and liquid or gas cooling. The optimum coolant temperature on its departure from the reactor is investigated according to the certain requirements. The optimum heating of the reactor coolant is considered, assuming that the average temperature of the coolant is constant; and the temperature of the coolant is constant when it leaves the reactor. Finally the thermodynamical properties of the ideal coolant and reactor cooling system are discussed. (OTS)

34007 AN ANALYSIS OF DYNAMIC CHARACTERISTICS OF PLUTONIUM- AND/OR THORIUM-RECYCLED REACTOR. I. REACTOR KINETIC EQUATIONS. Kunihiko Uematsu (Kyoto Univ.). Nippon Genshiryoku Gakkaishi, 4: 511-15(Aug. 1962). (In English)

Starting from the neutron balance equation, the reactor kinetic equations generally applicable to a plutonium- and/or thorium-recycled reactor are derived. The use of the newly defined effective fraction of delayed neutrons, β_{eff}, with these reactor kinetic equations simplifies the analysis of the dynamic behavior of a plutonium- and/or thorium-recycled reactor. (auth)

34008 HIGH TEMPERATURE EXPONENTIAL MEASUREMENTS AND ROOM TEMPERATURE CRITICAL SUBSTITUTION MEASUREMENTS ON SWEDISH R3/ADAM FUEL ASSEMBLIES IN HEAVY WATER. Normann P. Baumann, William E. Graves, Edward J. Hennelly, and George F. O'Neill (Du Pont de Nemours (E. I.) and Co., Aiken, S. C.). Nukleonik, 4: 200-8(July 1962). (TID-15037). (In English)

The Savannah River Laboratory has performed physics studies on D_2O lattices of fuel assemblies intended for the R3/Adam reactor being built by A. B. Atomenergi. Buckling temperature coefficients up to 220°C were measured at square lattice pitches of 24.0, 27.0, and 30.0 cm center-to-center, between fuel assemblies, in the Pressurized Subcritical Experiment (PSE). Central cell foil activation traverses were also made at room temperature and at 217°C. Two buckling measurements at room temperature were made in the Process Development Pile (PDP) at triangular pitches of 23.7 and 30.8 cm using a substitution technique in which R3/Adam fuel replaces similar assemblies composed of smaller diameter oxide rods. The experimental results compared well with calculations. (auth)

34009 STATISTICAL FLUCTUATIONS AND THEIR CORRELATION IN REACTOR NEUTRON DISTRIBUTIONS. W. Matthes (EURATOM C.C.R., Ispra, Italy). Nukleonik, 4: 213-26(July 1962). (In English)

It is the purpose of this paper to establish a method for the determination of the autocorrelation function of the output of a detector placed in a reactor. The analytical formulas derived for the autocorrelation function contain the physical parameters characterizing the kinetic behavior of the neutrons in the reactor system. As the autocorrelation function can easily be measured we have a useful tool for the experimental determination of these parameters. The following work is divided in three main chapters. In part A and B we give for the convenience of the reader a short summary of definitions and relations concerning correlation functions. Part C is a generalization of a F. de Hoffmann method to clarify the physical reason how correlation between two counter pulses can arise. In part D we develop a method for the computation of the statistical fluctuations of the number of neutrons in small space- and energy-regions. This is achieved by writing the space- and energy-dependent Boltzmann transport-equation in an equivalent probability formalism. We used the Chapmann-Kolmogoroff equation for the neutron balance in the reactor and derived from the corresponding probability generating function the formulas for the autocorrelation function. (auth)

34010 DETERMINATION OF THE REACTOR OUTPUT WITH THE HELP OF THE REACTOR NOISE. Rolf Schroeder (Hahn-Meitner-Institut für Kernforschung, Berlin). Nukleonik, 4: 227-9(July 1962). (In German)

From a relation which Cohn (Nuclear Sci. and Eng. 7: 472(1960)) has given for the mean spectral power density of the noise current of an ionization chamber in a reactor, a relation between the noise current at two suitably selected frequencies and the power output was derived on the basis of one-group-one-range diffusion theory. The method is advantageous in that it detects all neutrons present in the reactor with no supplementary approximation to the mean. It is principally suitable for application in the range of several watts. The procedure for carrying out the method is indicated, and results obtained on the BER are reported. (tr-auth)

34011 ASYMPTOTIC REACTOR THEORY IN PLANE GEOMETRY. Janusz R. Mika (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 7: 361-8(1962). (In English)

The critical conditions for slab reactor systems satisfying the assumptions of the asymptotic reactor theory are derived. The formulas are based upon the solutions of two basic problems in neutron transport theory, viz. one half-space and two adjacent half-spaces. (auth)

34012 PLAN FOR MAINTENANCE OF INSULATION ON CONTAINMENT STRUCTURES. H. H. Norden (Knolls Atomic Power Lab., Schenectady, N. Y.). Power Eng., 65: 37-8(Feb. 1961).

U. S. reactors having containment vessels in the shape of a sphere or a cylinder topped by a hemisphere are listed. The method of attaching insulation to the West Milton, N. Y., containment structure is described. A sampling plan is outlined for determining the condition of the insulation. (D.L.C.)

34013 PLAN FOR MAINTENANCE OF INSULATION ON CONTAINMENT STRUCTURES. H. H. Norden (Knolls Atomic Power Lab., Schenectady, N. Y.). Power Eng., 65: 39-41(Apr. 1961).

The practical technics of sampling of reactor containment structure insulation are described. A camera, operated from the top and ground, is used to photograph each sampled area. A method for determining when to repair or replace the insulation is outlined which uses a break-even chart of the costs of heat loss and repair. The costs of the sampling method are estimated. (D.L.C.)

34014 THE JOINT RESEARCH AND DEVELOPMENT PROGRAM QUARTERLY DIGEST, PERIOD FROM 1 APRIL TO 30 JUNE 1962. Vol. 2, No. 2. (United States–Euratom Joint Research and Development Program). 74p. ACCESS-145. $5.00 per yr.(Euratom)

Progress in joint EURATOM-United States research on nuclear fuels, reactor materials, nuclear engineering, reactor physics, and miscellaneous problems is reported. (M.C.G.)

34015 HOMOGENEOUS NUCLEAR REACTOR. (to Allmanna Svenska Elektriska Aktiebolaget). French Patent 1,239,202. July 11, 1960.

This homogeneous reactor comprises a core occupied by a solution of a fissile material in a moderator liquid and a breeder region enclosing the core and having a suspension of fertile material in the same moderator liquid. There is communication between the core and breeder to allow mass transfer and pressure equalization between the regions. The zones each have a separate circuit for removing heat by a mixer chamber situated inside the reactor vessel. The effluents coming from the two regions are mixed and led to a common device for separation into a clear solution and suspension, which are each led back to its corresponding circuit. To control the relative concentration of the two regions, an evaporator is provided separating a part of the moderator liquid from the solution occupying the core, the condensed separated moderator liquid being led into the breeder region. (NPO)

34016 IMPROVEMENTS RELATING TO THE REMOVAL OF HEAT PRODUCED BY THE FISSION PRODUCTS IN A NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,242,701. Aug. 22, 1960.

In order to remove the heat from fission products after shut-down in a gas-cooled reactor having a closed coolant circuit, the heat exchanger is shunted by a circuit enclosing a standby heat exchanger disposed above the level of the core structure for establishing, by thermosiphoning, a flow of reactor coolant between the core and the standby heat exchanger. A header tank is provided at a level above the standby heat exchanger for supplying heat exchange fluid to the standby heat exchanger, the heat exchange fluid being returned to the header tank by thermosiphoning after being heated. The header tank may be closed to the atmosphere, and may have cooling means, for example by water jacketing or a further heat exchanger. (NPO)

34017 TUBES PASSING THROUGH HOLES IN THE COVER OF A HETEROGENEOUS NUCLEAR REACTOR. (to Allmanna Svenska Elektriska Aktiebolaget). French Patent 1,244,114. Sept. 12, 1960.

Sometimes the covers closing the pressure vessels of reactors comprise a lower and an upper steel plate connected together. The lower wall of the cover, in case the reactor coolant is water, is lined with a sheet of stainless steel. The tubes passing through the cover, which inside are also in contact with the water, are also made of stainless steel tube, which is impossible to weld on the carbon steel plates of the cover. This problem is resolved by providing tubular assemblies passing through the cover with an outer tube made of carbon steel welded at both extremities on the carbon steel plates of the cover and an inner tube which is only welded at its lower extremity on the bottom of the cover. (NPO)

34018 NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,247,091. Oct. 17, 1960.

A reactor having vertical channels closed at the top by a biological shielding plug and extended at its lower extremity by tubular means supporting in the core region a chain of connected fuel elements is described. This supporting means is partially enclosed by a tube passing through a coolant exit header mounted inside the reactor vessel above the core. This latter tube forms a part of the reactor channel and communicates by lateral openings with the header. The lower end of the support tubes communicates with the inside of the hollow fuel elements in which coolant circulates from the bottom to the top. This lower end of the tubular support communicates by a lateral opening with the reactor channel at a level which also occupies the coolant exit header. This lateral opening may be closed gradually by an axially sliding valve, the movement of which is controlled by a steering rod rotatably mounted in the axis of the support means and passing through the shielding plug, to control the individual coolant circulation inside the reactor channel. (NPO)

34019 POWER MONITOR FOR NUCLEAR REACTOR. (to General Electric Co.). French Patent 1,247,832. Oct. 24, 1960.

For monitoring the power distribution throughout a reactor core disposed in a vessel and having a plurality of fuel-containing coolant flow channels, the penetrating radiation emitted from at least one of the flow channels is collimated. The intensity of the collimated radiation at several points remote from the assembly and outside the vessel is measured. The attenuation of the radiation is a function of the density and temperature of the coolant, so that the collimated radiation has an intensity which is a direct function of the power level. A further step consists in varying the neutron flux distribution within the reactor core while maintaining a predetermined total reactor power output. (NPO)

34020 PROCESS FOR THE CONTROL OF POWER DEVELOPMENT IN A LIQUID MODERATED HETEROGENEOUS NUCLEAR REACTOR. (to Société Indatom). French Patent 1,248,538. Nov. 7, 1960.

Control of power in a liquid moderated heterogeneous reactor consists in creating bubbles in the moderator by an auxiliary gas or vapor or by the vapor of the moderator itself. Means are provided for controlling the total volume occupied by the bubbles. Preferably this total volume is controlled by changing the pressure in the duct, feeding the gas or vapor into the reactor, or by changing the cross section of the feeding line. The quantity of bubbles and/or the size of them may be controlled by changing the temperature of the moderator. (NPO)

34021 ARRANGEMENT OF THE CORE OF A NUCLEAR REACTOR. (to Babcock and Wilcox Co.). French Patent 1,250,963. Dec. 5, 1960.

A reactor in which the moderator liquid also serves as a coolant circulating through the reactor core arrangement enclosed by a pressure vessel is described. This core arrangement comprises vertically disposed fuel element assemblies arranged in a lattice, each assembly comprises a box shaped container with a square cross section provided at its upper and lower extremities with fittings adapted to engage in an upper and a lower plate respectively. These plates support the core. In the spaces between adjacent

fuel element assemblies, elements for controlling the neutron flux are provided, movable control elements as well as fixed control elements, each having a cruciform cross-section, except at the periphery of the core, where the fixed control elements have T or L shaped cross-sections. During the core life these fixed control elements are gradually replaced by dummy elements, which do not contain neutron absorbing materials, so that the increasing fuel depletion and poisoning may be compensated. The fixed control and dummy elements also control the coolant flow in the spaces between the fuel element assemblies in order to limit the circulation therein. (NPO)

34022 PROCESS FOR THE REMOVAL OF HEAT DEVELOPED IN A NUCLEAR REACTOR. Sulzer Frères. French Patent 1,251,823. Dec. 12, 1960.

A reactor is described in which the removal of the developed heat is performed by a vaporizable fluid, this fluid passing in a circuit from a point of the highest fluid pressure to a point of the lowest fluid pressure. The circuit is closed by bringing the fluid in a liquid state from the point of the lowest pressure to the point of the highest pressure in the circuit. The fluid in the liquid state is first vaporized and afterwards led through a series of successive passages provided in the reactor. The vaporized fluid passes once or several times through the reactor where it is reheated. After a part of these passages the fluid is recooled in boilers in which the heat removed from the fluid is used to vaporize the fluid after it is brought up to a high pressure. Preferably a sole boiler is used for vaporizing the fluid. The recooling also may be carried out by injection of fluid in the liquid state into the vaporized fluid to be recooled. (NPO)

34023 IMPROVEMENTS RELATING TO HEAT EXCHANGE BY A WET METHOD, ESPECIALLY FOR THE HEAT REMOVAL IN NUCLEAR REACTORS. (to Société Nationale d'Étude and Construction de Moteurs d'Aviation). French Patent 1,252,670.

It was proposed to improve the heat exchange in a reactor by providing a coolant constituted by a wet gas in which also fine water droplets are present. However, when injecting the liquid phase at an extremity of a reactor channel, the quantity of the liquid phase changes along the channel, so that the heat exchange conditions change along the channel in a disadvantageous manner. To prevent this, the liquid phase is injected into the reactor channel along the whole length. The quantity of injected liquid may vary along the channel. The reactor coolant circulates in a closed circuit incorporating a heat exchanger in which the evaporated liquid phase is condensed and led back to the injection means. (NPO)

34024 IMPROVEMENTS RELATING TO CONTROL SYSTEMS FOR NUCLEAR REACTORS. (to General Electric Co. Ltd.). French Patent 1,255,862. Jan. 30, 1961.

To prevent a too high number of access holes passing through the reactor pressure vessel wall, a hollow control rod and a safety element can move inside the same reactor channel. The hollow control rod is coupled with a tube threaded outside and engaging in a female screw, the rotation of which induces the axial movement of the control rod. This threaded tube slides on a guiding tube in which the safety element may be displaced. This safety element is fixed to a piston sliding in the guiding tube and is composed of a series of chain-links each enclosed by a neutron absorbing cylinder. In case of emergency the safety element is blown by gas pressure into the reactor core. (NPO)

34025 DRIVE EQUIPMENT FOR THE CONTROL AND SAFETY RODS OF NUCLEAR REACTORS. (to Commissariat à l'Énergie Atomique). French Patent 1,256,114. Feb. 6, 1961.

This drive equipment for the control and safety rods of a reactor comprises a hollow screw, which is axially movable and engaged within a female screw mounted in the rotor of a first electric motor, and which supports by a coupling the control rod. A control shaft able to slide within the hollow screw is locked within the screw against rotation relative to it and is fixed to the rotor of a second electric motor which is able to induce a small angular displacement of the control shaft and so to the hollow screw, while a spring is provided for resetting this system. The rotor of the first motor induces the movement of the control rod during reactor operation, while the angular displacement acts on the coupling for releasing the control rod which afterward is propelled by spring action into the reactor. (NPO)

34026 CONTROL AND SHUT DOWN DEVICE FOR NUCLEAR REACTORS. (to Siemens-Schuckertwerke A.G.). French Patent 1,256,186. Feb. 6, 1961.

The principle of the control and shut-down device consists in the displacement of fissile material with neutron absorbing material, and vice versa, with an appropriated mutual overlapping of these materials. This device comprises an outer cylindrical element in the center of which a movable element is positioned. The outer element is constituted by two concentric tubes forming an annular interspace between them which in axial direction is subdivided in several partitions which alternately are filled with fissile or neutron absorbing material and alternately remain empty. The movable element is subdivided in partitions whereby one partition out of two is filled with neutron absorbing material. Preferably the empty partitions are suppressed or perforated to allow the passage of a moderator or cooling fluid. (NPO)

34027 NUCLEAR REACTOR WITH INTERIOR THERMAL INSULATION. (to Shell Internationale Research Maatschappij N. V.). French Patent 1,259,177. Mar. 13, 1961.

A reactor is provided with interior thermal insulating layers consisting of a finely divided non-crystalline carbonaceous material. Preferably this material is soot obtained from petroleum gas or petroleum oil distillates. The thermal insulating layers further comprise a double wall sealed around their edges, the interspace bounded by these walls being filled with the carbonaceous material. (NPO)

34028 MODERATOR CORE STRUCTURE FOR NUCLEAR REACTORS. (to General Electric Co. Ltd.). French Patent 1,261,010. Apr. 4, 1961.

In a moderator core structure, graphite blocks are arranged such that growth or contraction is permitted in the individual blocks. The axes of the reactor channels formed by borings in the blocks remain substantially fixed with respect to a common reference. This moderator structure comprises a plurality of lines of moderator blocks, adjacent lines being spaced from one another. The blocks are of hexagonal or octagonal section and are provided with axial keyways on their side faces while keys are placed in the keyways to connect opposite faces of adjacent blocks, thus restraining their movement perpendicular to the axis of the structure. (NPO)

34029 REACTOR SIMULATOR. F. G. G. van Baerle. French Patent 1,261,067. Apr. 4, 1961.

The simulator part representing the behavior of the reactor is formed by a transistor and an incandescent lamp or another heat source placed in the proximity of the transistor, this heat source simulating the neutron source serves

for the reactor startup. The base of the transistor is not connected with the transistor circuit, so that the latter has a low thermal stability. Because there is no base current the leakage current is generally very low, but it is strongly dependent upon the temperature and increases exponentially with the temperature of the collector-base junction. This temperature, in its turn, is dependent upon the collector dissipation and the heat supplied from the outside. If the leakage current exceeds a certain magnitude, the collector dissipation is thereby increased to such an extent that the increase of the leakage is sufficient to increase the temperature of the junction, whereby the transistor runs out of control, which is very similar to the way in which a nuclear reaction is built up in a reactor. The intensity of the nuclear reaction can therefore be symbolized by the leakage current of the transistor. The collector-emitter voltage, which is dependent upon the leakage current, is fed to an amplifier connected to a milliammeter. This meter can be calibrated in units of neutron flux density. (NPO)

34030 FUEL CHARGING AND DISCHARGING DEVICE FOR A NUCLEAR REACTOR. (to Winnett Boyd Ltd.). French Patent 1,261,191. Apr. 10, 1961.

A fuel charging and discharging apparatus for a bi-directional horizontally fueled gas cooled reactor has two charge-discharge machines and two centrally interrupted horizontal static track systems, one opposite each fueling face of the reactor within the pressure vessel. These charge-discharge machines run on the track systems. Two centrally intersecting vertical static track systems extending upward from the pressure vessel in two vertical elevator shafts are equipped with isolating valves and shielding gates. Two elevator dollies running on the vertical static tracks carry two horizontal tracks which can be interlocked within the central interruption of any corresponding pair of the horizontal static tracks. Two guide sheave dollies rest on the tops of the elevator dollies but are stopped at the junctions of the elevator shafts and reactor vessel so that they do not enter into the latter. Two enlargements on the tops of the elevator shafts enclose the machinery for raising, lowering, and locking the elevator dollies in the horizontal tracks, the machinery for reeling in and paying out hoses and cables from static bulkhead connections to the charge-discharge machines, gas locks and shielding gates through which new fuel elements are inserted, spent fuel element tippers, and the inlet ends of spent fuel element discharge pipes. The two spent fuel element discharge pipes are arranged to be emptied through a two valve fluid lock and liquid expansion tank into a fluid-filled spent fuel element flask. (NPO)

34031 CONTROL DEVICE FOR NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,261,673. Apr. 10, 1961.

A control device for reactors comprises means for computing a primary control factor proceeding from a temperature measured in a given point in the reactor and means for computing a supplementary control factor which is a function of the neutron flux in the reactor and of the coolant flow. Means are provided to combine the two factors in order to supply a combined control factor which influences the control means of the reactor. (NPO)

34032 NUCLEAR REACTOR PROVIDED WITH A DEVICE FOR PROVISIONAL STORAGE OF FUEL ELEMENTS. (to United Kingdom Atomic Energy Authority). French Patent 1,262,799. Apr. 24, 1961.

A device for provisional storage of fuel elements comprises at least one storage hole in the biological shielding and means for effecting a fluid flow within each storage hole for cooling or heating. The storage hole consists of a system of two concentric tubes, the walls bounding an inner and an outer duct for the fluid flow, while in the inner tube the fuel elements are placed. Another duct encloses one or several systems of two tubes; this latter duct is bounded by the shielding and may enclose a cooling fluid. The fluid flowing in the two tubes has closed circulation and passes through filters and a heat exchanger. (NPO)

34033 GUIDING DEVICE FOR THE FUEL ELEMENTS IN A NUCLEAR REACTOR. (to English Electric Co., Ltd.). French Patent 1,263,441. May 2, 1961.

A guiding device for charging and discharging vertical reactor channels is described. The guiding device comprises a main tube rotatably arranged in the access hole and which is cut out, so that over its lower portion this main tube shows a semi-circular cross-section. A movable guiding tube is linked to the main tube by a system of rods, so that a horizontal translation movement of this latter guiding tube may be performed in order to bring it into alignment with the reactor channel to be served. The system comprises two rods, each being articulated, with horizontal axis, at its upper extremity on the main tube and the movable guiding tube, while a pin at its lower extremity slides in slits provided in the guiding and main tubes. These rods are pivotally mounted one onto another to form a shear-like system. The upper extremity of the movable guiding tube is articulated to an intermediate tube which at its upper extremity is articulated to a vertical control tube axially positioned in the main tube and adapted to be moved in the direction of its axis by a screw and nut system in order to control the lateral displacement of the movable guiding tube. (NPO)

34034 PRESSURE TUBE FOR NUCLEAR REACTORS. (to Commissariat à l'Énergie Atomique). French Patent 1,263,814. May 8, 1961.

A pressure tube passing through a reactor has a central portion situated inside the reactor core and made of a material of good mechanical resistance and transparency to neutrons but difficult to connect by welding to the end portions of the pressure tube. As a rule this material is zirconium or a zirconium-based alloy. This central portion before it is placed into the core, is fitted at both ends with composite sleeves, each sleeve comprising an inner tubular piece welded to the central portion and an outer tubular piece of a material of the same kind as the material of the reactor structure, e.g., stainless steel. A fluid tight connection of the tubular pieces is obtained by co-extrusion, brazing, or hooping. After placing the pressure tube in the reactor, the outer tubular pieces of the sleeves are welded onto tubes forming a part of the reactor structure and centering the pressure tube. (NPO)

34035 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,264,273. May 8, 1961.

In gas cooled reactors it is often necessary to control the gas flow in the different channels by throttle-pieces of different sizes placed in the entrance of the different channels. In the case of vertical channels, in which the gaseous coolant flows from the bottom to the top, it is necessary to prevent any blowing out of the throttle-pieces which have to be replaceable, mechanical attachment however requires a complicated handling. In order to avoid this, a replaceable throttle-piece is provided reducing the channel cross section. It is arranged so as to be pushed against a centering element supporting this throttle-piece in order to be held in place by the resulting forces acting downwards, these forces are composed by the effects of the static gas pres-

sures acting on the surface of the throttle-piece and by the weight of the throttle piece itself. (NPO)

34036 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. (to Nuclear Power Plant Co., Ltd.). French Patent 1,264,420. May 8, 1961.

The structure of a solid moderator comprises a plurality of adjacent columns, each consisting of a series of piled blocks. Each block is provided with a vertical axial boring, and is aligned with other blocks in the column to form a reactor channel. This alignment is ensured by a system of keys and keyways which prevents any movement of the blocks of the same column. The mutual position of adjacent columns is ensured by a system of spacing elements placed in borings or grooves provided in the blocks in several different levels of the moderator structure, the axis of these borings or grooves following two mutually perpendicular horizontal directions. Each spacing element engages in borings or grooves of two adjacent blocks of adjacent columns. The elements have a tubular shape or the form of a bar and are made of stainless steel or zirconium, as the dimensions of these materials remain essentially constant under the influence of irradiation. (NPO)

34037 IMPROVEMENTS RELATING TO THE CONSTRUCTION OF NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,266,010. May 29, 1961.

In a reactor the core is disposed within the pressure vessel on a support structure transmitting the weight of the core to a cylindrical inner skirt forming an extension within the vessel of an outer skirt supporting both the vessel and the reactor core. The support structure is so shaped that it does not block the fluid circulation between the inlet ducts in the vessel wall to the channel extremities at the bottom of the core. The support structure comprises a platform in the form of a grid held by a peripheral support ring and a second horizontal support ring with a smaller diameter disposed at a lower level and resting on the support skirt. The grid is further supported by a series of vertically spaced elements each fixed at its lower extremity on the second support ring. (NPO)

34038 COOLING CIRCUIT FOR THE MODERATOR LIQUID OF A NUCLEAR REACTOR. (to Commissariat à l'Énergie Atomique). French Patent 1,267,956. June 19, 1961.

A cooling circuit, which is independent of the liquid moderator and which serves for removing the greater part of the energy developed in the reactor is described. For cooling the liquid moderator, the coolant is evaporated and the vapor flows to a condenser connected to the bottom of the moderator vessel for natural circulation. Preferably the moderator is heavy water, while light water is used in the condenser coolant circuit passing through a reflector space enclosing the moderator vessel. The condenser is also connected to the top of the moderator vessel and is provided with an electric heater to bring the small heavy water quantity in the collector to the boiling temperature, serving in this way as pressurizer during the shut down of the reactor so that the pressure in the system is a little higher than atmospheric pressure. (NPO)

34039 IMPROVEMENTS RELATING TO MODERATOR CORE STRUCTURES FOR NUCLEAR REACTORS. (to General Electric Co., Ltd.). French Patent 1,268,244. July 19, 1961.

The structure of the solid moderator comprises a plurality of adjacent columns, each consisting of a series of square section graphite blocks and tile members alternately piled. The blocks in one layer are spigotted to the blocks of the next block layer by the tile members which have holes in alignment with holes in the block in order to form a reactor channel within the column. The stabilization of the core is secured by a combination of corner keys and side face keys engaging keyways provided in the tile members in order to connect adjacent tile members. The corner keys are preferably of cruciform shape adapted to engage keyways formed parallel to the respective diagonal of each of groups of four adjacent tile members, while the side face keys are preferably of rectangular or square section engaging keyways formed at right angles to the respective side faces. (NPO)

34040 LOCKING DEVICE FOR THE FIXING OF ELONGATED OBJECTS IN PARTICULAR IN NUCLEAR REACTORS. (to Elliott Brothers Ltd.). French Patent 1,268,775. June 26, 1961.

A device for locking an elongated object, e.g., a control rod in a given position in a channel of a reactor, comprises an outer tubular piece in which an inner tubular piece may move between two levels, this movement being induced by the movement of the control rod head. The wall of the inner tubular piece is provided at two levels near its upper and lower extremity respectively with two series of holes. In each of these holes a small ball is placed having a diameter a little bigger than the wall thickness, so that the balls either engage in grooves provided in the wall of the outer tubular piece or occupy an inner position so that they form a stop for the control rod head and transmit the movement of the head to the inner tubular piece. An up-and-down movement of the head induces a corresponding up-and-down movement and a simultaneous unidirectional step by step rotation of the inner tubular piece. This step by step rotation is steered by a system of ramp shaped grooves provided at the outer surface of the inner tubular piece and cooperating with pins mounted in the wall of the outer tubular piece. The rotation changes the position of the balls with respect to the grooves in the inner wall of the outer tubular piece, so that the balls after each step alternately form or do not form stops for the head. In the locked position the head rests on the lower balls. (NPO)

34041 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. R. Taylor (to Nuclear Power Plant Co. Ltd.). French Patent 1,268,807. June 26, 1961.

The moderator structure of a reactor consisting of a plurality of adjacent columns, each provided in its center with a vertical reactor channel, is described. Each column is fixed at its bottom on the platform constituting the support. Each column consists of static and dynamic columns alternately disposed so that four dynamic columns surround one static column and vice versa. Each of the static columns consists of a series of blocks of square section each having a central hole for constituting the reactor channel. These blocks are piled one above another, while each block of a dynamic column is spaced in vertical direction from a succeeding block by four wedge shaped members sliding on correspondingly inclined end faces of the blocks to be spaced. Each of these wedge shaped members abuts with a vertical face of it against lateral faces of blocks of an adjacent static column and is able to slide along this side face. Succeeding blocks of a dynamic column are interconnected with tubular pieces to ensure the continuity of the reactor channel. The elements of the moderator structure are restrained by horizontal belts at levels at which the wedge shaped members are disposed. (NPO)

34042 SODIUM COOLED HEAVY WATER MODERATED NUCLEAR REACTOR. (to U. S. Atomic Energy Commission). French Patent 1,268,929. June 26, 1961.

This sodium cooled heavy water moderated reactor comprises a containment shell enclosing a sealed vessel containing the heavy water moderator and a plurality of tubes passes through this vessel so that the edges of their open extremities are connected in a fluid tight manner with the vessel wall. Below and above the vessel a lower and an upper header chamber are disposed within the containment shell. These chambers are connected by barrier tubes each passing through a tube of the vessel, thus forming pairs of tubes each bounding an annular interspace communicating with the atmosphere enclosed within the containment shell. Inside and spaced apart from the barrier tubes, fuel element tubes pass in which liquid sodium flows and which are interconnected by sodium header systems placed in the lower and upper header chamber respectively. The annular interspaces between the barrier and fuel element tubes communicate with the header chambers and form part of a helium filled closed circuit. This means ensures the thermal insulation and separation of the hot sodium circuit from the heavy water moderator which is held at a relatively low temperature. (NPO)

34043 IMPROVEMENTS RELATING TO THE ENTRANCE AND EXIT HEADERS FOR THE COOLANT OF A HETEROGENEOUS NUCLEAR REACTOR. (to Allmanna Svenska Elekriska Aktiebolaget). French Patent 1,269,566. July 10, 1961.

A heterogeneous pressure tube reactor, preferably moderated by heavy water, has an entrance header situated at the top of the reactor and comprising two vertical plates one at the bottom and one at the top. These plates are assembled by vertical sockets forming the upper extensions of the pressure tubes and supporting the exit header inside and spaced from the horizontal walls of the entrance header, the exit header being provided at its inner wall with a thermal insulation. The coolant flows from the entrance header into the sockets via their lateral openings and from the sockets downwards into the inner space formed between the pressure tubes and the inner tubes centered in the pressure tubes and enclosing the fuel elements. The coolant then rises in the inner tubes reaching finally the exit header via further lateral openings in the sockets. (NPO)

34044 CONTROL SYSTEM FOR NUCLEAR REACTORS BASED ON THE USE OF NEUTRON ABSORBING FLUIDS. (to Società Elettronucleare Nazionale Senn). French Patent 1,269,659. July 10, 1961.

In a reactor vertical tubular containers are partially filled with a neutron absorbing liquid, the level of which is controlled for controlling the reactivity of the reactor. Preferably the space in each tubular container above the liquid level is occupied by a pressurized gas admitted to the space by a tube connected to the upper extremity of the container by valves to a high and low pressure gas container respectively, while the lower extremity of the tubular container is connected with a pressurized liquid container. The pressure in the low pressure gas container is lower than the pressure in the pressurized liquid container, while the pressure in the high pressure gas container is higher, so that the level of the neutron absorbing liquid may be changed by simply opening and closing the valves in an appropriate manner. (NPO)

34045 NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,269,965. July 10, 1961.

In order to protect the pressure tubes in a reactor from too high temperatures, a deflection tube is placed in each pressure tube for enclosing the fuel elements and to form a narrow annular interspace with the inner surface of the pressure tube. Before entering the pressure tube the coolant flow is divided into a principal portion flowing over the fuel elements and into a secondary portion flowing through the annular interspace. In case the coolant is constituted by steam an additional flow of water is provided in the annular interspace. After having passed through the reactor the principal and the secondary flow portion are reunited. (NPO)

34046 CONTROL DEVICE FOR A NUCLEAR REACTOR. (to Escher Wyss S.A.). French Patent 1,270,728. July 24, 1961.

A reactor control device consists of at least two neutron absorbing control elements simultaneously movable in opposite directions and always being inserted in the same degree, the elements being interconnected by a transmission cable or chain. Preferably several neutron absorbing elements are interconnected to form a chain led over a chain-sprocket situated outside the reactor core for the drive and/or the deflection of the chain. (NPO)

34047 PROCESS AND EQUIPMENT FOR DISCHARGING THE FUEL ELEMENTS FROM A NUCLEAR REACTOR. (to Société Indatom). French Patent 1,271,538. Aug. 7, 1961.

A fuel element discharge process consists in guiding the spent fuel elements from the discharge machine placed outside the reactor containment shell by a hydraulic piping system to the storage pool. The equipment consists of collecting pipes connected to the discharge face of the reactor and pipings adapted for hydraulic conveying of the fuel elements to the storage pool. These conveying pipings are associated with machines for decanning or putting the fuel elements in containers, operations being performed by remote control or remote handling within the hydraulic fluid. (NPO)

34048 SEALING DEVICE FOR MECHANICAL CONTROL. (to Commissariat à l'Énergie Atomique). French Patent 1,272,066. Aug. 16, 1961.

A mechanical system ensuring fluid tight displacement of a reactor control rod consists of a fluid tight vertical cylindrical elastic wall in which in axial direction slides a carriage supporting the control rod. The wheels of the carriage touch the inner surface of the wall. Outside the wall a control element is provided movable in the vertical direction and supporting rollers enforcing a local elastic deformation of the cylindrical wall at two opposite points, so that the rollers engage, by the deformed wall, two wheels of the inner carriage. In this way the inner carriage and control rod follow the movement of the outer control element. Means are provided for bringing together and spreading the rollers for performing the engagement and non-engagement of the rollers with the inner carriage, so that at non-engagement the inner carriage freely moves down by the action of gravity to shut down the reactor. (NPO)

34049 PROCESS FOR INCREASING THE THERMAL EFFICIENCY OF A NUCLEAR REACTOR. (to Licentia Patent-Verwaltungs-G.m.b.H.). French Patent 1,272,893. Aug. 21, 1961.

In order to increase the thermal efficiency of a reactor, especially of a boiling water reactor, the coolant entrance temperature is controlled in a manner such that the maximum admissible fuel element surface temperature is produced in each reactor channel. In a boiling water reactor with natural circulation arising through the vertical reactor channels, this control is performed by feeding cold water via nozzles into the lower extremities of the different channels, whereby it is mixed with the water being in natural circulation. The cross sections of the nozzles in-

crease from the periphery to the center of the reactor in order to feed more cold water to the inner channels than to the outer ones. (NPO)

34050 CONTROL ROD DRIVE. (to General Dynamics Corp.). French Patent 1,272,954. Aug. 28, 1961.

A control rod drive includes an unbalanced movable element connected to the control rod, a two-phase electric motor, and gearing connecting the motor and the element for moving the element to a selected rest position. The motor has its phases normally adjusted so as to produce in the rest position a minor amount of torque sufficient to neutralize the torque applied to the motor through the gearing by the unbalanced weight connected to the element. A lifting electromagnet is mounted on the lower end of the element in order to hold an armature for the magnet, this armature being connected with the control rod by a connecting rod and sliding within a cylindrical casing, the connecting rod passing through a gland at the bottom of the cylindrical casing extending below the normal level of the fluid in the reactor. On the connecting rod a piston is mounted which slides with a sealing ring in the bore of the cylindrical casing, so that when the lifting magnet is deenergized, the control rod falls in the reactor. This cylindrical casing is provided near its bottom with lateral openings forming throttle means for the liquid and serving as a controlling means to reduce the rate of descent of the control rod as the piston approaches the bottom of the cylindrical casing. The connecting rod is long enough so that in its lowest position the armature will remain above the normal fluid level. (NPO)

34051 APPARATUS FOR TAKING SAMPLES IN A NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,273,227. Aug. 28, 1961.

In order to check the state of the graphite moderator it is necessary to take samples. An apparatus for sampling includes an oblong casing adapted to be lowered by cables into a vertical reactor channel with a hollow cylindrical cutting tool for boring out a cylindrical sample from the graphite wall of the channel. The front face of the tool on which the cutters are mounted is also provided with a pivoting tool for cutting up the sample. This pivoting tool is mounted between two adjacent cutters at the front face and does not disturb the cutting action during the forward movement of the cutting tool. Means are provided for controlling the movements of the tools according to a predetermined sequence; this means is driven by a pneumatic motor situated in the top of the casing. During the cutting action a cooling fluid is spread over the cutters. (NPO)

34052 CONTROL ROD DRIVE EQUIPMENT FOR A NUCLEAR REACTOR. (to AEI-John Thompson Nuclear Energy Co., Ltd.). French Patent 1,273,312. Nov. 12, 1959.

Control rod drive equipment for a reactor enclosed by a pressure vessel includes means for transmitting the rotation of a driving axle placed outside the pressure vessel to a second axle inside the vessel, the rotation of the second axle controlling the movement of the control rod. This transmission means comprises a cylindrical body coupled with outer driving axle and provided with windings to form an electromagnet. This cylindrical body encloses the side faces of a cylindrical protuberance in the pressure vessel wall, while in the protuberance a permanent magnet is mounted on the second axle and forms together with the electromagnet an electromagnetic coupling. (NPO)

34053 CHARGING AND DISCHARGING INSTALLATION FOR GAS COOLED NUCLEAR REACTORS. (to Simon Carves Ltd. and General Electric Co. Ltd.). French Patent 1,274,209. Sept. 11, 1961.

Gas cooled reactors provided with an installation for charging and discharging fuel elements during full load operation have the disadvantage that as the elements are charged into or discharged from a reactor channel, the impedance to the gas flow in that channel varies considerably. The resulting variation in thrust upon the elements can make charging and discharging difficult. Thus a fuel element charge/discharge system is provided that arranges the fuel elements to remain at all times in the gas flow path and to present a substantially constant impedance to the gas flow. Preferably the charge/discharge system includes a charging vessel containing a magazine for the storage of fuel elements, a charge tube through which fuel elements can be charged into the reactor from the reactor vessel and vice versa, and a further tube adapted to connect the charging vessel with the pressure vessel of the reactor and to constitute a return path for gaseous coolant. The further tube encloses part of the charge tube between the charging vessel and reactor in order to provide an annular space for the return path. (NPO)

34054 IMPROVEMENTS RELATING TO CONTROL RODS OF NUCLEAR REACTORS. (to Hawker Siddeley Nuclear Power Co., Ltd.). French Patent 1,274,264. Sept. 11, 1961.

A control rod drive adapted to insert a control rod into the bottom of the reactor core comprises a drive mechanism being placed in the reactor vessel. This control rod drive means comprises a pinion, the driving axle of which passes through the pressure vessel and the biological shielding, a toothed rack vertically moved by a rotation of this pinion and mounted in a slotted inner tube, and an outer tube into which this inner tube slides. At the lower end of the inner tube a first lever is articulated which supports at its other extremity the control rod, while a second lever is articulated at the lower extremity of the outer tube, so that the first lever swivels and moves the control rod when a relative movement between the tubes is produced. Spring means work against the action of the driving motor so that when the motor couple disappears, this spring means induces the control rod into the reactor core. (NPO)

34055 GRABS FOR NUCLEAR REACTOR FUEL ELEMENTS. (to United Kingdom Atomic Energy Authority). French Patent 1,274,293. Sept. 11, 1961.

A grab is described for hoisting or lowering the fuel elements charged within vertical channels in a reactor comprises a tubular body open at its bottom and suspended at its upper extremity by a hoisting cable. The fuel elements to be handled are stacked one above another, each being provided at its top with lateral finger projections for centering within the channel. The grab body shows axial slots along its tubular body for accepting the fuel element projections. The slotted grab body is composed of two co-axial slotted tubular pieces sliding on each other, the upper parts of the slots being enlarged. When the lower parts of the corresponding slots of these tubular pieces are in alignment, the grab may be placed over the fuel element. For locking the grab with the fuel element, the inner tubular piece is rotated with respect to the outer one so that the alignment of the corresponding slots disappears at their lower parts, the composite slots now being closed so that the projections of the fuel element are restrained in the grab. The tubular pieces are provided at the lower ends with axial grooves which mutually engage during a short axial displacement of the inner tubular piece, increasing the stiffness of the tubular body. (NPO)

34056 SERVICING MECHANISM FOR GAS COOLED NUCLEAR REACTORS. (to General Electric Co., Ltd.). French Patent 1,275,735. Oct. 2, 1961.

A servicing or fuel handling mechanism includes a rotatable charge tube adapted to be inserted into the pressure vessel for servicing a group of reactor channels. This tube has an articulated radial end portion adapted to engage the ends of the channels in sequence when the charge tube is rotated. A charge chute encloses the charge tube and shows at its lower portion a lateral axial slot through which the articulated radial end portion may swivel out. Within the lower portion of the charge chute an axially movable member is positioned having a locating spigot at its lower end adapted to engage in a locating aperture in a guide pan above the reactor core. The axial position of the axially movable member is controlled by sensing means in the form of pegs mounted on the guide pan and dependent on the azimuthal position of the charge chute. The upper end of the axially movable member has a cam surface providing two stepped portions which engage a follower on the radially articulated end portion of the charge tube, so that this end portion can have one of two radial positions depending upon the azimuthal position of the charge chute. (NPO)

34057 GRIPPER DEVICE FOR TAPES. Henry J. Bellarts (to U. S. Atomic Energy Commission). U. S. Patent 3,059,303. Oct. 23, 1962.

The relationship of a two-part plug or dummy fuel element and a flat thin metallic tape that is releasably gripped edgewise by the plug is described. The plug and tape shift a column of fuel elements lengthwise in a reactor process tube, through a pull transmitted to the tape by an operator and a push of the plug against the column of fuel elements. (AEC)

34058 NON-CORROSIVE PLUTONIUM FUEL SYSTEMS. Arthur S. Coffinberry and James T. Waber (to U. S. Atomic Energy Commission). U. S. Patent 3,060,108. Oct. 23, 1962.

An improved plutonium reactor liquid fuel is described for utilization in a nuclear reactor having a tantalum fuel containment vessel. The fuel consists of plutonium and a diluent such as iron, cobalt, nickel, cerium, cerium–iron, cerium–cobalt, cerium–nickel, and cerium–copper, and an additive of carbon and silicon. The carbon and silicon react with the tantalum container surface to form a coating that is self-healing and prevents the corrosive action of liquid plutonium on the said tantalum container. (AEC)

34059 NUCLEAR REACTOR. Jerome Sherman, John E. Sharbaugh, William L. Fauth, Jr., Nunzio J. Palladino, and Philip G. DeHuff (to U. S. Atomic Energy Commission). U. S. Patent 3,060,111. Oct. 23, 1962.

A nuclear reactor incorporating seed and blanket assemblies is designed. Means are provided for obtaining samples of the coolant from the blanket assemblies and for varying the flow of coolant through the blanket assemblies. (AEC)

Power Reactors

Refer also to abstract 32902.

34060 (AERE-R-4080) CALCULATION OF HIGH ENERGY NEUTRON SPECTRA IN HETEROGENEOUS REACTOR SYSTEMS. S. B. Wright (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Aug. 1962. 45p.

The Monte Carlo technique was used to compute the neutron energy spectrum in heterogeneous reactors in the range 10 kev to 14 Mev. The reactors considered were HERO, PLUTO, and Calder Hall. It is shown that the statistical errors in the calculated spectra can be reduced sufficiently to give reliable predictions of the reaction rates for fast neutron reactions with thresholds below about 5 Mev. The calculated spectra were used to predict the reaction rates of various threshold detectors, and where possible these predictions were compared with results of experiments. Agreement is good in the large reactor systems, but discrepancies were found for PLUTO, where the calculated spectra may be significantly in error owing to the neglect of axial leakage and streaming. (auth)

34061 (APEX-602) PARAMETRIC ANALYSIS OF SOME FAST OXIDE-FUELED SYSTEMS WITH MODERATING REFLECTORS. A. W. Culp, Jr., J. W. Stephenson, L. H. Thacker, and D. I. Weinberg (ASTRA, Inc., Raleigh, N. C.). June 1, 1959. For General Electric Co. Flight Propulsion Lab. Dept., Cincinnati. Contracts AF 33(600)-38062 and AT(11-1)-171. 196p.

The fuel requirements of small, extremely high-temperature, fast-reactor systems containing high void fractions and utilizing thermalizing reflectors were evaluated for application in the ANP program. The fuels employed in these studies were solid-state solutions of uranium dioxide and/or plutonium dioxide in thorium dioxide. Parametric analyses were performed for systems 12, 18, and 24 inches in diameter with fixed axial dimensions and for various radial and front reflector thicknesses. In addition to these studies a number of specific "shaft-through" systems were also investigated. Fuel requirements ranged from as low as 96 pounds of Pu^{239} for a 12-inch-diameter system to approximately 935 pounds of U^{235} for one of the shaft-through designs. In general, loadings were somewhat lower than was anticipated from previous analyses. The uranium fuel requirements are approximately 50 to 100% higher than those for a corresponding plutonium-fueled system for the reflected reactors. It appears that the uranium systems are more favorably receptive to the addition of moderating materials than the plutonium systems. (auth)

34062 (BAW-1202) NUCLEAR MERCHANT SHIP REACTOR. ZERO POWER TEST — CORE I. R. M. Ball and A. L. MacKinney (Babcock and Wilcox Co. Critical Experiment Lab., Lynchburg, Va.). July 1960. Contract AT(30-3)-274. 133p.

Reported are the results of some tests on NS Savannah Core I, normal and conjugate, giving information of excess reactivity, control rod holddown, initial critical conditions, shipboard loading guide, temperature effects on reactivity, four flux distributions. Some of the results are as follows: excess reactivity for Core I, Normal, $14.6; control rod holddown for Core I, Normal, $17.5; core I, conjugate, is subcritical with all rods in; and the water temperature effect on reactivity is negative between 16 and 51°C. (auth)

34063 (CEND-155) ABWR DESIGN AND DEVELOPMENT QUARTERLY PROGRESS REPORT, JANUARY 1 THROUGH MARCH 31, 1962. (Combustion Engineering, Inc. Nuclear Div., Windsor, Conn.). Apr. 15, 1962. Contract AT(11-1)-1062. 56p.

Design and development work on the Army Boiling Water Reactor are described in sections on control rod drive mechanism, plant simulation, core evaluation, and PL production fuel elements. Reports on plant development and evaluation were previously issued. Details of the critical experiment program are included. This program is intended to check the analysis methods used in the PL-2 design, and in particular, to check the effects of the control rods and the B-stainless steel pins on reactivity and power distribution. Information is included on small cores with excess reactivity and full size core loading. (J.R.D.)

34064 (DANATOM-03-62) GAMMA II—A 200 MW BOILING WATER REACTOR POWER STATION. A Revision. (Danish Assn. for Industrial Development of Atomic Energy, Hellerup). June 1962. 73p.

A revision was made of the GAMMA design study for a 200 Mw boiling water reactor power station. A complete redesign of the reactor building and its installations resulted. Only minor changes were made in the designs of the turbine plant, control room, and auxiliary equipment. Design data and basic calculations are presented. The reactor and auxiliaries, steam supply system, turbine plant, electrical system, plant instrumentation, and utility systems are described. Pressure suppression, civil engineering, refueling, and costs are discussed. (M.C.G.)

34065 (DP-775) HEAVY WATER MODERATED POWER REACTORS PROGRESS REPORT, AUGUST 1962. R. R. Hood and L. Isakoff, comps. (Du Pont de Nemours (E. I.) & Co. Atomic Energy Div., Wilmington, Del.). Sept. 1962. Contract AT(07-2)-1. 32p.

The HWCTR was operated for the first time at power levels in the megawatt range in conjunction with initial startup of the facility. Operation of the reactor with driver fuel elements alone was generally satisfactory at all power levels investigated to date (20 Mw maximum). Examination of the core of a UO_2 tube that experienced inner sheath collapse during irradiation revealed that the oxide was at a much higher temperature than had been intended. Initial data were obtained on the effects of H_2 concentration and ZrH platelet orientation on the mechanical properties of Ni-free Zircaloy-2. A preliminary reference design of a 300 Mw(e) organic-cooled D_2O-moderated power reactor was established. (auth)

34066 (EURAEC-47) CAN-1—QUARTERLY PROGRESS REPORT FOR THE PERIOD APRIL 16, 1960 TO JULY 15, 1960. Part A. Technical Report. Quarterly Report No. 2. (Ansaldo S. p. A., Genoa). July 30, 1960. Work Performed under United States–Euratom Joint Research and Development Program. Contract 003-60-1RDI. 15p.

The efforts of the Ansaldo research group were devoted mainly to the completion of the low pressure loop and to air-water tests. Only mixing experiments were performed. The design of the high pressure loop was completed and materials procurement was started. Plans are reported to present the experimental data already obtained and the data from tests now in progress in the next technical report. (J.R.D.)

34067 (GA-3132) 40-MW(E) PROTOTYPE HIGH-TEMPERATURE GAS-COOLED REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending March 31, 1962. (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Contract AT(04-3)-314. 84p.

Activities in a developmental program concerned with the 40-Mw(e) prototype HTGR are reported. This prototype is a high-temperature, gas cooled, graphite moderated reactor. Progress is reported on development of materials for the reactor core, development of the core and reflector, and development of reactor equipment and plant auxiliaries. Other activities concerned with experimental reactor physics and over-all plant analysis are described. (J.R.D.)

34068 (GEMP-144) 630A MARITIME NUCLEAR STEAM GENERATOR. Progress Report No. 2. (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Sept. 28, 1962. Contract AT(40-1)-2847. 81p.

A layout of a reduced-height 630A assembly (34 to 23 ft) was prepared and is presently being evaluated for use in a merchant vessel. While shielding studies indicate the need for some rearrangement of the shield materials, the desired radiation constraint can be obtained without an increase in shielding weight. A preliminary stress analysis of the pressure vessel, flow path analysis, and insulation evaluation was completed and showed no major problems. Evaluation of the total containment design indicates a design pressure of 45 psig. The Critical Experiment (CE) mockup is about 80% complete. The CE tank and dolly is about 50% complete. The CE hazards report was reviewed and approved. The draft of the test program and procedures document is 75% complete. The LPT control room modifications were made, and the draft of the standard operating procedures completed. The CE fuel was inspected and a significant portion was found to be of no use, about 60% requires recoating. Creep and oxidation test time on some of the fuel sheet has exceeded 3000 hr with no significant oxidation or elongation on any of the samples. The nickel–chromium alloy sheet high-temperature (1750°F) stress and oxidating testing have exceeded 5000 hr with elongations below 0.8% except for one sample of 2.3%. Experimental fuel sheet samples were prepared and comparative property studies were initiated. Fabrication of the ring test assembly, 3-F-1, for test in the MTR is essentially complete. The design of the test ring for seal evaluations was initiated. A detailed schedule for the work in FY 63 was prepared and issued for comments and concurrence. (auth)

34069 (MND-MD-2543) PM RESEARCH AND DEVELOPMENT—TASK 1.0—CORE 2 REFERENCE DESIGN REPORT. T. Cox, K. Ellingsworth, and R. Lightner (Martin-Marietta Corp. Aerospace Div., Baltimore). Aug. 1962. Contract AT(30-1)-2706. 123p.

The reference design of Core 2, which is being designed primarily as a replacement core for the PM-1 and PM-3A nuclear power plants is described. In addition, the thermal and hydraulic capabilities were investigated; these indicated applicability of the core to higher powered PM-type plants. Core 2, like the first generation cores, utilizes fully enriched uranium-stainless steel fuel elements having a tubular configuration; and it is water moderated and water cooled. External dimensions are identical to those of the PM-1 Code 1, a diameter of 23.1 inches and an active length of 30 inches. Design criteria are discussed. Core nuclear and thermal performance was considerably improved over that of the earlier cores. Lifetime was increased from 18.7 to 26.8 Mw-yr. The core may be shut down cold, with one rod fully withdrawn. Throughout life, the shutdown margin under this condition exceeds 1% $\Delta k/k$. Thermal output of the core, with a flow rate of 2125 gpm and a mean temperature of 463°F, was increased from 10.4 to 29.7 Mw(t). Core mechanical design was somewhat simplified. The control rod guide rail was revised to provide additional cell locations within the core. The hydraulic resistance of the upper core grid plate was lowered to permit bulk boiling along the hotter fuel elements without compromising hydraulic stability. (auth)

34070 (NAA-SR-Memo-7415) DIFFUSION LENGTH MEASUREMENT IN SGR GRAPHITE. R. W. Campbell (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 29, 1962. Contract [AT-11-1-GEN-8]. 18p.

The thermal neutron diffusion length in the SGR graphite was measured in two graphite stacks. The stacks were nominally 4 ft high by 5 ft in diameter and 8 ft high by 7 ft in diameter. Thermal flux distributions were determined in the axial and radial directions by activation of both dysprosium and indium-alloy foils. The diffusion length

was found to be 51.4 ± 0.2 cm (ρ = 1.697 g/cm^3) (small stack), 52.2 ± 0.3 cm (ρ = 1.668 g/cm^3) (large stack), and 54.5 ± 0.2 cm (ρ = 1.60 g/cm^3) (average of above). The effective graphite absorption cross section was then calculated from this last figure using two possible choices of the transport cross section. The two values were based on steady state and pulsed methods of measuring λ_{tr}. The resulting absorption cross sections were σ_a = 3.83 mb (λ_{tr} = 2.74 cm; steady state) and σ_a = 3.64 mb (λ_{tr} = 2.55 cm; pulsed). (auth)

34071 (NYO-9786) SURVEY OF COMPONENT REQUIREMENTS AND AVAILABILITY FOR GAS-COOLED NUCLEAR REACTOR POWER PLANTS. Interim Report. Zesces Zudans and John A. Goff (Franklin Inst. Labs. for Research and Development, Philadelphia). June 1961. Contract AT(30-1)-2512. 239p. (I-A2392-1)

Helium, nitrogen, carbon dioxide, and other gases suitable as reactor coolants were evaluated. It is shown that because of the helium conservation program, recently authorized by legislation, sufficient helium will become available for domestic power plants and for the requirements of the Euratom group. Tables of thermodynamic properties for helium and molecular nitrogen were computed from the Beattie-Bridgman equation of state. Specific enthalpy, specific entropy, isobaric specific heat, specific heat ratio, compressibility factor, specific volume, and acoustic velocity are tabulated over the range 250(10)800(50)2500°K by 14.696, 25(25)500(50)900(100)2000(250)2500 psia. T-S charts for the same range for both helium and molecular nitrogen are given. (auth)

34072 (ORNL-1227) AIRCRAFT NUCLEAR PROPULSION PROJECT QUARTERLY PROGRESS REPORT FOR PERIOD ENDING MARCH 10, 1952. W. B. Cottrell, ed. (Oak Ridge National Lab., Tenn.). May 7, 1952. Contract W-7405-eng-26. 207p.

Analysis of the circulating fuel aircraft reactor was extended to systems incorporating intermediate heat exchangers, various secondary coolants, liquid moderators, and heavier reactor shielding. Design of the ARE reactor core is discussed. Progress is reported in the design of the reactor, fluid circuits, the reactor building, and associated equipment. Development of plumbing for high-temperature fluoride mixtures is reported. Techniques of preparation, purification, and handling fluoride mixtures were investigated. Techniques of pumping, sealing, and controlling fluoride coolants were developed along with lubrication methods. Criticality studies for the ARE, the ANP, and the simulated General Electric direct-cycle reactor are reported. Angular and energy-dependent radiation measurements on the mockup of the divided shield are discussed. Research on ducts included detailed measurement of the effect of duct geometry on neutron transmission, and confirmation of a neutron transmission theory for ducts. Design details of the Tower Shielding Facility are presented. Additional cross-section measurements were obtained on the 5-Mev Van de Graaff and the time-of-flight neutron spectrometer for use in reactor cross-section determinations. Measurements of the total cross section of Fe were made at 0.7 to 3.6 Mev. Research on high-temperature liquids for use as a fuel-coolant for the circulating-fuel reactor is discussed. Several fluoride systems are being investigated. Tests of fluoride, hydroxide, and liquid metal corrosion are reported. The effect of various additives on fluoride and hydroxide corrosion is being evaluated. Investigation of metallurgical processes involved in the construction and assembly of a high-temperature reactor core is reported. Information on fabrication of control rods, welding and brazing of core structure, and creep and stress-rupture of metals is presented along with data on viscosity, thermal conductivity, heat capacity, and vapor pressure of fluoride mixtures. Results of a theoretical analysis of heat transfer in circulating-fuel reactors were used to establish the design parameters for the core fuel circuit. Mathematical expressions for natural convection associated with liquid fuels were developed for the case of turbulent flow. Data on the heat transfer of boiling Hg is included. Radiation damage studies included those on fuel capsules, inpile liquid loops, and creep and thermal conductivity in metals. A summary of findings from a survey of the supercritical-water reactor is included. Procedures for the analysis of fluoride mixtures for corrosion products and changes in composition are reported. (J.R.D.)

34073 (ORNL-1294) AIRCRAFT NUCLEAR PROPULSION PROJECT QUARTERLY PROGRESS REPORT FOR PERIOD ENDING JUNE 10, 1952. W. B. Cottrell, ed. (Oak Ridge National Lab., Tenn.). Aug. 5, 1952. Contract W-7405-eng-26. 190p.

Analysis of the circulating-fuel aircraft-reactor systems incorporating intermediate heat exchangers led to the use of a spherical-shell type of heat exchanger and shield arrangement; a diagram of such a heat-exchanger arrangement is shown. A design study was undertaken of a circulating-fluoride-fuel reactor core in which a thick reflector replaces the moderator. Minor modifications were made in the design of the aircraft Reactor Experiment to be constructed at ORNL; the changes made during the last quarter and the progress made in detailing the system and procuring outside manufactured components are discussed, as well as a procedure that was outlined for the operation of the reactor. Brief descriptions of pumps and valves which were operated successfully with molten fluoride mixtures for extended periods of time at 1500°F are given. NaK-to-NaK and Na-to-air heat exchangers were operated for long periods. Efforts devoted to developing instruments for flow, pressure, liquid-level, and control of the ARE and experimental high-temperature-liquid systems are reported. Techniques are discussed for the manufacture, transfer, and loading of fluoride mixtures without contamination. Studies of the circulating-fuel aircraft reactor led to the conclusion that power oscillations in this system are strongly dampened by a mechanism associated with the circulation of the fuel. A critical assembly of the box-type, direct-cycle reactor, was investigated for the GE-ANP program; fission rate, flux measurements, reflector effects, and temperature response were determined. A résumé of the results from an earlier series of experiments with a graphite-moderated reactor is also presented. Measurements of the energy and angular distribution of gamma radiation from the divided-shield mockup around the Bulk Shielding Reactor were continued; the spectrometer positions for the measurements are listed, and a graph shows spectra at various distances from the reactor with and without the divided-shield mock-up. In another experiment with this reactor, the effect of radiation from the side of the reactor shield that scatters in air and penetrates the crew compartment was measured. The albedo of neutrons and gamma rays on concrete was determined with artificial sources to facilitate calculations for the Tower Shielding Facility. A series of short experiments on the gamma radiation attenuation of Fe and Pb in regions close to the source were completed in the Lid Tank. The results of the gamma-attenuation measurements are presented graphically for 63% Fe – 37% water; 63% Fe – 37% borated water; solid Fe thermal shield in water; and solid Pb shadow

shields in water. The air-duct research in the Lid Tank and Thermal Column Facilities has continued. The Lid Tank research was concentrated on large-scale mockups of annular designs, and the Thermal Column work was devoted to a series of experiments to provide a better understanding of the important attenuation processes. The total neutron cross section measurements of Li^6 show only one resonance, which is at 270 kv. The research on high-temperature liquids was mostly devoted to the development of a satisfactory fluoride fuel for the ARE. The phase diagrams of several binary, ternary, and quaternary fluoride systems were examined. Tentative phase diagrams are presented of two- and three-component fluoride systems containing Rb, Na, K, and ZrF_4; these studies were undertaken to determine the coolant and fuel-solvent possibilities of the systems. The corrosion-research effort was divided among static and dynamic tests of fluorides, hydroxides, and liquid metals. Tests showed that small additions of Na, K, Mn, and Ca are beneficial in minimizing fluoride corrosion. Various fluoride mixtures were circulated in thermal convection loops. Stainless steel loops generally plug after short periods, whereas Inconel loops consistently operate up to 1000 hours. In the study of the reaction products of container materials and the hydroxides, a new compound was found that is believed to be $NaNiO_2$. The metallurgical processes involved in the construction and assembly of a high-temperature reactor are being developed. Brazing alloy tests for flowability, corrosion resistance, and joint strength, revealed that the 60% Pd-40% Ni alloy is superior in a fluoride environment. Powder mixtures of B_4C with Fe and with Al_2O_3 are being hot pressed for use as ARE safety and regulating rods. Loose-powder sintering was investigated as a technique for the fabrication of solid fuel elements. Heat-transfer and physical-property measurements on the various hydroxides and fluorides were continued. Determinations of viscosity, thermal conductivity, density, heat capacity, and vapor pressure were made on several fluoride mixtures. Pile irradiations of proposed fuel mixtures in Inconel capsules comprised the greater part of the effort in the radiation damage program, although measurements were continued on inpile creep, and thermal conductivity of metals. The substitution of ZrF_4 for Be in the fuel mixture necessitated a review of existing methods for the determination of alkali metals, U, and the major corrosion products. A rapid and accurate method for the determination of total alkali metals was developed. A volumetric method for the determination of Zr is being studied. Improvements in the Fe determination method that eliminate the interference of Zr were made. In the determination of sulfide in fluorides and eutectics, the colorimetric method that depends upon the formation of methylene blue was adapted. It was found that ZrO_2 can be determined in ZrF_4 because of its insolubility in oxalic or tartaric acid. (J.R.D.)

34074 (ORNL-2106(Pts.1-5)) AIRCRAFT NUCLEAR PROPULSION PROJECT QUARTERLY PROGRESS REPORT FOR PERIOD ENDING JUNE 10, 1956. A. W. Savolainen, ed. (Oak Ridge National Lab., Tenn.). Sept. 4, 1956. Contract W-7405-eng-26. 285p.

Activities in a program of research on circulating fuel reactors and other ANP projects are reported. Information and data are included on aircraft reactor engineering, chemistry, metallurgy, heat transfer, properties of reactor materials, radiation damage, fuel processing, critical experiments and reactor shielding. The specific objectives of the program include design, construction, and operation of the Aircraft Reactor Test (ART). The ART is a 60 Mw circulating-fuel reflector-moderated reactor and adequate means for heat disposal. (J.R.D.)

34075 (ORNL-TM-78) THERMAL-STRESS AND STRAIN-FATIGUE ANALYSES OF THE MSRE FUEL AND COOLANT PUMP TANKS. C. G. Gabbard (Oak Ridge National Lab., Tenn.). Oct. 3, 1962. Contract W-7405-eng-26. 73p.

Thermal-stress and strain-fatigue analyses of the MSRE fuel and coolant pump tanks were completed for determining the quantity of cooling air required to obtain the maximum life of the pump tanks and to determine the acceptability of the pump tanks for the intended service of 100 heating cycles from room temperature to 1200°F and 500 reactor power-change cycles from zero to 10 Mw. A cooling-air flow rate of 200 cfm for the fuel pump tank was found to be an optimum value that provided an ample margin of safety. The coolant pump tank was found to be capable of the required service without air cooling. (auth)

34076 (SL-1949) ENGINEERING EVALUATION STUDIES, HEAVY WATER MODERATED POWER REACTOR PLANTS. W. A. Chittenden and G. F. Hoveke (Sargent and Lundy, Chicago). June 30, 1962. Contract AT(38-1)-213. 99p.

Results of a series of engineering evaluation studies related to heavy water moderated power reactor plants are discussed. Results indicate that boiling D_2O direct cycle plants can produce power more cheaply than any other type of D_2O moderated system. A program is in progress to develop a computer program for the economic optimization of heavy water moderated reactor plants of various capacities. Development of cost equations associated with the turbine-generator plant structures and reactor plant auxiliary systems is described. (J.R.D.)

34077 (TID-15256) TERMINATION STATUS AND PROCEDURES FOR CONTINUATION OF SM-1 TASK XII PLANT RESPONSE AND SYSTEM PERFORMANCE TESTS A-700 AND A-701. J. A. Barrett and E. F. Phelps (Alco Products, Inc., Schenectady, N. Y.). Feb. 15, 1962. Contract AT(30-3)-326. 229p. (AP-Note-398)

The termination status of a program to analyze and test the SM-1 system response to transient electric and steam loads and verify the analytical representation by comparison with test results is presented. The objective of the program is to develop an accurate analytical model by which steam transient response requirements can be predicted in the design of future plants where reliable power quality and isolated operation are required. (J.R.D.)

34078 (TID-16697) A SURVEY OF THORIUM REACTOR TECHNOLOGY. Paul Hogroian (Division of Operations Analysis and Forecasting, Engineering Branch, AEC). Aug. 1962. 34p. (OA:R-28)

Selected aspects of thorium reactor technology are reviewed. Information is included on reaction kinetics, the present status of Th-breeder technology, and the outlook for further development of this technology. (J.R.D.)

34079 (WAPD-260) THE SECOND REFUELING OF CORE 1 OF THE SHIPPINGPORT ATOMIC POWER STATION. C. E. Center, H. Feinroth, and J. E. Yingling (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Aug. 1962. Contract AT(11-1)-Gen-14. 120p.

The second seed refueling of the Shippingport Atomic Power Station was begun on August 16 and completed on October 24, 1961. The planning and methods used to implement the second refueling and the lessons learned during it are described. The scope of refueling operations, preparations for refueling, radioactivity control, and reactor components and refueling equipment are discussed. (M.C.G.)

34080 (WAPD-MRP-99) PRESSURIZED WATER REACTOR (PWR) PROJECT, TECHNICAL PROGRESS RE-

PORT FOR THE PERIOD JUNE 24, 1962–AUGUST 23, 1962. (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Contract AT(11-1)-Gen-14. 127p.

Progress is reported on the PWR. Topics covered include: PWR plant support, plant modification, modification coordination program, reactor engineering, metallurgy of core materials, Shippingport cores, special materials and quality control, and reactor physics. (M.C.G.)

34081 (AEC-tr-5420) TO THE CONDITIONS OF USING TRANSFER FUNCTIONS OF THE REACTOR. Pavel Kovanits. Translated by Lydia Venters (Argonne National Lab., Ill.) from Atomnaya Energ., 12: 123-8(Feb. 1962). 9p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, as abstract no. 14324.

34082 (EURAEC-40) CAN-1—PROGRESS REPORT FOR THE PERIOD NOVEMBER 1 TO DECEMBER 31, 1960. Quarterly Report No. 5. (Centro Informazioni Studi Esperienze, Milan). Feb. 1, 1961. Work Performed under United States–Euratom Joint Research and Development Program. Contract 002-59-11RDI. 13p. A translation of CISE-R-32.

Progress is reported on heat transfer experiments in annular ducts, refined experiments on flow distribution and film thickness, and corrosion and erosion experiments. The heat transfer experiments were performed on annuli with external and bilateral heating. A large amount of experimental data concerning the annuli heated on the external wall only were computer analyzed. Data from a series of refined experiments on phase distribution performed in the pressurized Ar loop were analyzed. Other work is reported on corrosion of stainless steel and Zircaloy-2 by steam–water mixtures. (J.R.D.)

34083 N. S. SAVANNAH—ELECTRIC SYSTEM IN THE FIRST MERCHANT NUCLEAR REACTOR SYSTEM. E. A. Geary (New York Shipbuilding Corp., Camden, N. J.). Applications and Ind., No. 61, 183-93(July 1962).

In addition to normal considerations for shipboard electric plants, the design for nuclear-powered merchant vessels is based on the need for an uninterrupted source of power. The installation of main, auxiliary, and emergency generating plants, the utilization of automatic devices for generator synchronizing and power source transfer, as well as the application of special interior communications and alarm systems, unique to nuclear-powered vessels, effectively eliminate the probability of complete power loss on the N. S. Savannah. (auth)

34084 CALCULATION AND ANALYSIS OF THE THERMODYNAMIC CYCLE PARAMETERS OF NUCLEAR POWER STATIONS. I. S. Kochenov, N. L. Voinov, and N. N. Ershova (Kurchatov Inst. of Atomic Energy, USSR). At. Energ. (USSR), 13: 38-46(July 1962). (In. Russian)

Determination of the optimal thermodynamic cycle parameters presents difficulties because this notion itself, as used in the design of nuclear power stations, is not clearly established; it depends on several technological and economic factors. Keeping this in mind, the absolute internal efficiency η_i was chosen as the indicator of the optimization of the system. A two-circuit gas-cooled power station with steam at two pressures was chosen for the study. Thermodynamic considerations indicated that a system with a two-stage pressure has a more favorable η_i than a single-stage system; a three-stage system would be better but more complicated. In the calculations, use was made of known thermodynamic formulas, such as the saturation temperature, the enthalpy of water under conditions of saturation, the enthalpy of the dry, saturated steam, the latent heat of vaporization, and the enthalpy of the superheated steam. By means of the equations derived η_i may be solved on a digital computer for a number of variants such as the temperature drive, the pressure prevailing in the condenser, the feed water temperature, and the coolant gas temperature. These empirical formulas of the thermodynamic properties of water and steam make it possible to compute the solution for many heat transfer problems. (TTT)

34085 PROBLEMS OF NUCLEAR POWER GENERATION. A. P. Aleksandrov. At. Energ. (USSR), 13: 109-24 (Aug. 1962). (In Russian)

Utilization of nuclear energy is becoming economical even in the USSR which possesses sufficient coal and oil reserves for about 4 centuries; the problem is of special importance in countries which already must import their fuel supply. Development of reliable methods is more important than economic considerations. Calculations indicate that as the number of nuclear power stations increases, the power generated by them will soon become competitive with thermal stations. Three methods are being considered for utilizing nuclear fuels. Direct use of fission of the fuel such as U^{235} is of interest for constructing lightweight stations intended for remote areas, or for building reactors used in ship propulsion, as in the case of the icebreaker "Lenin." Utilization of the "breeder" principle involves using materials such as U^{238} or Th^{232}. Such reactors are used at the Novovoronezh and the Beloyarsk power stations. Many problems remain to be solved, including the determination of the physical constant of fissionable and structural materials, study of heat transfer problems, and behavior of materials after irradiation. In addition, reactor safety, control, and safety problems are under intensive study. (TTT)

34086 INSTRUMENTATION AT BERKELEY NUCLEAR POWER STATION. R. E. B. Dawson and M. W. Jervis. J. Brit. Inst. Radio Engrs., 23: 17-33(Jan. 1962).

From the shut-down power of about 10 watts upward, neutron flux instrumentation is used for reactor power measurement and to operate safety trips. At high powers, control and protection are based on temperature measurements (fuel element, channel gas, graphite etc.). Selected fuel element temperatures can shut down the reactor, others being recorded by multi-point recorders and automatic loggers. The shut-down initiating devices shut down the reactor only if at least two out of the three give a trip signal. The system of faulty fuel element detection employs an automatic logger which computes averages, giving discrimination between random and significant rises in CO_2 gas activity. Equipment is also provided for the detection of leaks between steam and CO_2 circuits; in addition radiation activity in and around the station is monitored. Gas and steam flows are measured and the data transmitted by a pneumatic system. The display equipment for the major instrumentation is centralized in or near the station control room. (auth)

34087 HINKLEY POINT TEMPERATURE SCANNING EQUIPMENT. R. I. Ostler and J. M. Tyrrill (Marconi Instruments Ltd., St. Albans, Hertfordshire, Eng.). J. Brit. Inst. Radio Engrs., 23: 83-8(Feb. 1962).

The equipment described is a data handling system with magnetic drum storage. Approximately 600 graphite, fuel element, and gas exit thermocouples are scanned and the remainder of the 720 input positions are used for self-checking purposes. It is a high speed system, taking 144 seconds for a complete scan; there is a store of 20 scans, representing 48 minutes. Long life and extreme reliability

of input switching is achieved using reed relays driven by transistors in a matrix arrangement. Analogue to digital conversion is performed directly on the outputs of the thermocouples which are linearized so that the output is in degrees C rather than thermocouple emf. Readout is on strip printers, a typewriter and a tape punch. The operating range of the equipment is from 0 to 799°C, the long term overall accuracy (excluding thermocouple variations) being ±3°C. (auth)

34088 HINKLEY POINT NEUTRON FLUX SYSTEM. P. J. Keeley (Marconi Instruments Ltd., St. Albans, Hertfordshire, Eng.). J. Brit. Inst. Radio Engrs., 23: 89-93(Feb. 1962).

Conventional ion chamber and logarithmic amplifier techniques are employed without involving elaborate and sophisticated instrumentation. A minimum of different instrument types has been aimed at. A comprehensive built-in system of operational testing has been designed which obviates the need for portable test gear, and reduces the number of personnel required to carry out such testing. (auth)

34089 THE A.C. COUPLED SHUT-DOWN AMPLIFIER AS A SAFETY DEVICE IN NUCLEAR POWER STATIONS. J. A. Hazell (General Radiological Ltd., Stanmore, Middx., Eng.). J. Brit. Inst. Radio Engrs., 23: 461-4(June 1962).

The shut-down amplifier supplies information to the safety circuits, so as to produce a reactor shut-down when the power exceeds a pre-determined level. A current, proportional to the reactor power, is obtained from a neutron-sensitive ionization chamber. This current is compared with that obtained from a variable reference source whose output is calibrated in terms of equivalent reactor power. The shut-down amplifier gives a safe output only when the reactor power is below the reference setting. Any other condition, including fault conditions in the amplifier, must produce a trip signal. The two most essential design features of such an amplifier are absolute reliability of trip action in response to reactor power levels and low fault rate to minimize the number of spurious reactor shut-downs. (auth)

34090 DIPHENYL SHOWS ADVANTAGES FOR 1. DIRECT-CYCLE NUCLEAR PLANTS. 2. DUAL-PURPOSE PLANTS. D. W. Bareis and G. S. Leighton (Marquardt Corp., Van Nuys, Calif.). Power Eng., 66: 43-5(Sept. 1962).

The main advantage of diphenyl is that its saturated vapor superheats on expansion and does not form moisture. In the Direct Cycle Diphenyl Reactor concept, diphenyl is heated in the reactor and passed to the flash boiler, where ~15% of it flashes to vapor. Diphenyl may be used in conventional plants as well as in nuclear power plants, and in dual-purpose plants for producing both power and process heat. Comparisons are made between the costs of steam and diphenyl oil-fired and nuclear plants. (D.L.C.)

34091 ELECTRICAL ASPECTS OF HUNTERSTON NUCLEAR GENERATING STATION. J. Henderson, G. F. Kennedy, and K. J. Wootton. Proc. Inst. Elec. Engrs., (London), Pt. A, 109: 259-70(Aug. 1962).

A survey is given of the electrical-engineering aspects of the design which are considered to be of general interest. The location of Hunterston and its relationship and connections to the supply system of the South of Scotland Electricity Board are first described. The special operational features of a nuclear station and the overall station-control system are discussed. The auxiliary supply system is then dealt with, and the differences between nuclear and conventional station practice are indicated, with particular reference to the extensive "essential supplies" system. The largest electrical auxiliaries are the gas-circulator drives, and since their design is unusual these drives are considered in some detail. Finally, a description of the starting up and operation of the station is given. (auth)

34092 USER EXPERIENCE WITH POWERFUL WARD LEONARD D.C. MACHINE DRIVES FOR GAS CIRCULATORS AT CALDER HALL. E. L. Desbruslais (United Kingdom Atomic Energy Authority, Calder Hall, Cumb., Eng.). Proc. Inst. Elec. Engrs., (London), Pt. A, 109: 279-87(Aug. 1962).

It is described how frequent flashovers on powerful "limit" d-c motors and generators [maximum power-speed product (kw × rpm) = 1.6×10^6] for gas circulator drives, ascribed to copper drag, have been virtually eliminated, and an account is given of some unusual experiences with carbon brushes and types of brush box. Experience has shown that such machines operating at 600 v (20 v per segment average) can be run day and night continuously at full load with few unscheduled outages, provided that they are kept absolutely clean and maintained at periodic intervals, and copper drag is removed when seen. It is important, therefore, to select a brush grade which produces the minimum commutator wear and does not cause copper dragging. (auth)

34093 GAS-CORE REACTORS COULD TRIPLE I_{sp} OF NUCLEAR SPACECRAFT. Irwin Stambler, ed. Space/Aeronautics, 38: No. 4, 54-9(Sept. 1962).

A survey of the state of the art of gas-core reactor design is presented which covers vortex, plasma-core, and quartz-bottle configurations. The crucial problem of containing the fissionable material is analyzed in detail, and advanced models of the various proposed gas-core reactors and their problems are discussed. The performance of an experimental, ground-based Russian gas-core reactor is reviewed. Estimates are given of the performance to be expected from gas-core reactors as spacecraft power plants. (auth)

34094 THE NPD NUCLEAR POWER STATION ELECTRICAL SYSTEM AND THE STATISTICAL APPROACH TO ITS DESIGN. R. A. Brown (Canadian General Electric Co., Ltd., Peterborough, Ont.). Preprint Paper No. 62-1343. Prepublication Copy. 15p. $1.00.

The electrical system designed for the Nuclear Power Demonstration (NPD) Generating Station and the statistical approach used to make decisions as the design progressed, are described. NPD is a 22 Mw nuclear power station and is heavy water-moderated and heavy water-cooled and uses natural uranium as the fuel. An electrical system was designed for NPD which is quite similar to that which would be found in a conventional generating station of the same rating. However, because of the critical nature of some of the processes during all phases of operation including shutdown, a great deal of emphasis was placed on reliability. Throughout the design, circuit configuration and equipment selection stressed reliability as well as cost. (auth)

34095 THERMIONIC NUCLEAR REACTORS. E. P. Gyftopoulos and G. N. Hatsopoulos (Massachusetts Inst. of Tech., Cambridge, Mass.). Preprint Paper No. 62-1429. Prepublication Copy. 27p. $1.00.

The coupling of nuclear reactors with thermionic converters is reviewed. The principles of operation of thermionic converters and the present and anticipated advancements in the state of the art of thermionic conversion are discussed. Particular emphasis is given to the parameters that influence the optimum performance and life of converters such as work function of emitter and collector,

spacing between the same, temperatures of operation, cesium vapor pressure, and materials. The discussion is illustrated by a series of experimental results and amplified by theoretical analysis. Three conceptual designs of thermionic nuclear reactors are reviewed. These designs are presented as reference points to establish the requirements on performance characteristics and materials as well as the problem areas that result from the marriage of nuclear reactors and thermionic converters. It is concluded that the most efficient way of coupling thermionic converters with a reactor is by dispersing the converters throughout the volume of the nuclear core, and that thermionic nuclear reactors have several unique features for space, submarine propulsion, and applications in remote areas. (auth)

34096 THE NPD NUCLEAR POWER STATION CONTROL AREA. B. A. Oliver (Canadian General Electric Co. Ltd., Peterborough, Ont.). Preprint Paper No. CP-62-1364. Prepublication Copy. 15p. $1.00.

Early in April, 1962, the Nuclear Power Demonstration (NPD) reactor went into operation for the first time. Some of the features of the control wing of the station are described. A few of the considerations in the control area design arose from special control requirements for nuclear systems; however, most of the design features would be equally applicable to a conventional fossil-fueled steam plant. The sunken control console design and the control area layout is described at some length and is related to current control room design practice and to the minimization of operating manpower requirements. (auth)

34097 REACTOR CONTAINMENT VESSEL ELECTRICAL PENETRATIONS FOR THE CAROLINAS VIRGINIA TUBE REACTOR PROJECT. E. T. Witt and R. E. Andrews (Stone and Webster Engineering Corp., Boston). Preprint Paper No. CP-62-1373. New York, American Institute of Electrical Engineers, 1962. 10p. $1.00.

The Carolinas Virginia Tube Reactor (CVTR) Project posed the problem of providing leaktight penetrations through a containment vessel for numerous electrical circuits. The major features of the CVTR plant are outlined. The need for electrical penetrations and the criteria on which their designs were based are discussed and a brief description is given of penetrations provided for previous projects. The penetrations provided for the CVTR project are described in detail. Prototype penetrations were laboratory tested to assure that the designs, as finally adopted, would meet the requirements for low leakage. These tests were made with apparatus including a halogen leak detector. The test procedure and test results are discussed and evaluated. Fabrication, assembly, installation, and the completed containment vessel leak test are reviewed. (auth)

34098 THE ADVANCED EPITHERMAL THORIUM REACTOR CONCEPT FOR POWER UTILITY APPLICATION. D. T. Eggen (Atomics International, Canoga Park, Calif.). Preprint Paper No. CP-62-1399. New York, American Institute of Electrical Engineers, 1962. 15p. $1.00.

The AETR is a unique power reactor concept utilizing an epithermal-intermediate energy neutron spectrum and fuel breeding with a thorium–uranium-233 fuel cycle. Results of the research, development, and evaluation program show the feasibility of achieving economically competitive energy generation with the AETR utilizing the proven heat transfer characteristics of sodium and taking maximum advantage of present-day central station practices in a "free nuclear-fuel market." (auth)

34099 NUCLEAR REACTOR SYSTEM FOR PRODUCING A SUPERHEATED WORKING FLUID. (to United Kingdom Atomic Energy Authority). French Patent 1,239,164. July 11, 1960.

In a reactor installation the working fluid is converted from the liquid state into the saturated vapor state in evaporators, while this saturated-vapor is superheated in the channels of the reactor. A portion of this superheated vapor is used for producing mechanical energy, while another portion is used in the heat exchangers for delivering the evaporation heat. In this installation no pumping of the working fluid in vapor state is necessary. Suitably the working fluid in the liquid state coming from the condenser is pumped into the evaporators, these evaporators being connected in parallel with respect to the circuits of the evaporating liquid. The first evaporator is heated from superheated steam coming from a first group of reactor channels, is recooled there, and is fed again for superheating into a second group of reactor channels after which it is fed to the second evaporator and so on. The last group of reactor channels delivers a part of its superheated vapor to another heat exchanger and a part directly to the turbine for producing mechanical energy. (NPO)

34100 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. (to Hawker Siddeley Nuclear Power Co. Ltd.). French Patent 1,243,732. Sept. 5, 1960.

In a reactor means are provided for passing organic liquid coolant through different parts of the core in two coolant paths so that, when the reactor is in operation, most of the organic coolant passes through a first coolant path to remove the greater part of the heat generated in the core, while the remainder of the coolant passes through the second coolant path to emerge from the core at a higher temperature than the coolant emerging from the core in the first coolant path. The associated reactor installation comprises a heat exchanger with evaporator and superheater sections, the evaporator being connected in a circuit including the first coolant path so that coolant in this path passes from the reactor core to the evaporator. The superheater is connected in a further circuit including the second coolant path so that coolant in this path passes from the reactor core to the superheater. The coolant emerging from the superheater joins via a flow valve the coolant coming from the first path before the latter enters the evaporator. This flow valve is used to control the coolant temperature in the second path. (NPO)

34101 IMPROVEMENTS RELATING TO TUBULOUS STEAM GENERATORS AND TO STEAM GENERATING INSTALLATIONS COMPRISING WATER-COOLED NUCLEAR REACTORS. (to Babcock and Wilcox Ltd.). French Patent 1,248,919. Nov. 14, 1960.

This tubulous steam generator for water-cooled reactors comprises a pressure vessel containing a bank of upright, spaced tubes, the ends of which are shaped to extend laterally to tube plate means disposed at the inner ends of inlet and outlet chambers projecting laterally from the pressure vessel wall into the pressure vessel. A jacket surrounds the tube bank to form, between the tubes, an internal riser space open at the bottom to a liquid space of the vessel and in communication at the top with a steam space of the vessel, while, between the yacket and the wall of the vessel, an external downcomer space is provided. At the lower end of the tube bank support means are arranged to support the tubes at the lateral extensions. At each of the three levels two adjacent sets of spacing strips are arranged with the strips of one set crossing the strips of the other set and with the strips so disposed as to space apart adjacent rows of the upright tubes. These three pairs of sets maintain the spacing of the tubes of the tube bank. (NPO)

34102 NUCLEAR POWER PLANT COMPRISING A SUPERHEATER. A. Vandeghen and N. Salier. French Patent 1,251,489. Dec. 12, 1960.

In order to increase the power and thermal efficiency of a nuclear power plant, the turbine is fed with superheated steam instead of saturated steam. The superheating of the steam produced by the reactor is performed by a device using conventional fuel, e.g., coal or oil. The plant is provided with means which give it the usual structure of a steam generator so that it may function as such in the event of cessation of saturated steam production by the reactor. (NPO)

34103 PRIME MOVER INSTALLATION. (to Brown, Boveri and Cie A. G.). French Patent 1,265,483. May 23, 1961.

In case the prime mover is a steam turbine, the condenser, feeding pump, and boiling water reactor are placed within the same pressure vessel. According to another embodiment the prime mover is a gas turbine driven by hot gas heated in a reactor, while that gas passes through cooling means before it is refed by a gas compressor into the reactor, all these means being placed within the same pressure vessel. (NPO)

34104 IMPROVED NUCLEAR POWER REACTOR. (to Foster Wheeler Ltd.). French Patent 1,265,778. May 23, 1961.

A power reactor consisting of a pressure vessel filled with water as a moderator and enclosing tubes in which the fuel elements are arranged is described. Steam is led over these elements in order to cool them. The water moderator is kept at a temperature and pressure essentially equal to those of the saturated steam coolant entering the tubes. Preferably the top portion of the pressure vessel is separated by a horizontally divided wall from the remaining vessel space and forms an entrance header for the steam coolant, while tubes of the first kind are suspended at their upper open extremities by this dividing wall. Inner tubes enclosing the fuel element are placed coaxially in the tubes of a first kind and pass through the header space. The steam coolant first flows downwards from the header through the interspace bounded by the coaxial tubes, rising afterwards through the inner tube before leaving the reactor vessel. The reactor is also provided with vertical control tubes with heavy water, the level of which is controlled for controlling the reactor reactivity. (NPO)

34105 PROCESS FOR CONTROLLING THE REACTIVITY OF THERMAL NUCLEAR REACTOR ESPECIALLY OF A HIGH TEMPERATURE REACTOR. (to Société Nationale d'Étude and Construction de Moteurs d'Aviation). French Patent 1,270,023. July 17, 1961.

A process for controlling the reactivity of a thermal reactor consists in incorporating in the moderator a material in which the neutron capture cross section changes with the temperature and shows a resonance at a temperature higher than the reactor working temperature, so that the increase in absorption with increasing working temperature is sufficient to ensure the stability of the chain reaction in the proximity of the working temperature. Preferably the incorporated material consists of indium or rhodium in a powdery form mixed with the uranium and incorporated in the graphite moderator. According to another embodiment the indium or rhodium is used in the form of a carbide. (NPO)

Production Reactors

34106 EPITHERMAL REGENERATIVE NUCLEAR REACTOR USING THORIUM AS FERTILE MATERIAL. (to North American Aviation, Inc.). French Patent 1,204,590. Jan. 27, 1960.

This epithermal regenerative reactor comprises in the core a heterogeneous lattice of thorium and uranium fuel. This fuel is enclosed by a relatively light material for supplying an epithermal neutron spectrum and a fertile material of thorium. Preferably the light material consists of sodium coolant. The core further comprises a moderator lattice consisting of a plurality of hollow moderator blocks through which the sodium coolant circulates. The fuel elements consist of thorium–uranium alloy of 3 to 15% uranium-233 in thorium, while the core comprises from 0 to 50% beryllium as a moderator. The inner surfaces of the moderator blocks are suitably clad with a metal sheet, e.g., zirconium, stainless steel, titanium and Inconel, while means for controlling the chain reaction are placed within the channels occupied by fuel elements. (NPO)

34107 PROCESS AND PLANT FOR THE THERMAL BREEDING OF PLUTONIUM. K. Diebner. French Patent 1,226,419. July 11, 1960.

For breeding plutonium in a thermal reactor, the reactor system must have a central reactor stage and one or more outer reactor stages, wherein the central reactor stage is operated in a super-critical state emitting thermal neutrons and the outer stages are operated in a subcritical state. The transition from the super-critical stage to the subcritical stage is carried out discontinuously, in one or several steps, so as to use a conversion factor greater than one of a uranium moderator mixture with a K smaller than one. (NPO)

Research Reactors

34108 (AAEC/TM-121) CALCULATION OF REACTIVITY CHANGES IN HIFAR DUE TO FUEL AND POISON CHANGES. C. D. McKenzie and J. W. Connolly (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Jan. 1962. 21p.

Empirical methods are given for calculating reactivity changes in HIFAR with changes in fuel loading, poison concentration, and temperature variations. The procedures are derived from the analysis of typical operating programs, reinforced by analogue computer analysis of variation of the important fission product poisons Xe^{135} and Sm^{149}. (auth)

34109 (AAEC/TM-125) USE OF A RADIOISOTOPE METHOD TO MEASURE FLOW IN THE HIFAR LIGHT WATER COOLING CIRCUIT. W. R. Ellis and C. K. Beswick (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Feb. 1962. 7p.

A radioisotope method was used to measure the flow in the light water circuit of HIFAR. A mean value of 756 lb/sec was obtained which is in fair agreement with the conventional Dall tube method. Attempts to measure the flow through individual cooling towers were not entirely successful, but some useful information was obtained. (auth)

34110 (AAEC/TM-128) MEASUREMENT OF THE PROMPT NEUTRON LIFETIME IN HIFAR. J. K. Parry (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Feb. 1962. 14p.

The reactor transfer function of HIFAR was measured at low power and compared with the calculated response to determine the prompt neutron lifetime. Lifetime values in the range 600 to 800 microseconds, depending on the position of absorbers within the core and reflector, were ob-

mined with an estimated error of less than 100 microseconds. (auth)

34111 (AAEC/TM-132) A METHOD FOR CONSTRUCTING THE COMPLETE HIFAR NEUTRON SPECTRUM FROM THE AVAILABLE SPECTRAL INDICES. G. B. Lang (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Mar. 1962. 13p.

A method is given for constructing the complete neutron spectrum of a well-moderated thermal reactor such as HIFAR, from the total effective flux, the temperature of the Maxwellian, the epithermal spectral index, and the total integrated fission flux. A sample calculation is included. (auth)

34112 (HW-73701(Rev.)) IN-REACTOR MONITORING OF ZIRCALOY-2 PRTR PRESSURE TUBES. PART I. SEPTEMBER 1960–MAY 1962. D. R. Doman and P. J. Pankaskie (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 1962. Contract AT(45-1)-1350. 32p.

Remotely operable experimental equipment was developed and used in the PRTR for: visually examining the internal surface of the pressure tubes, measuring the inside diameters of the pressure tubes, measuring the eccentricity of the helium gas annulus between the Zircaloy-2 pressure tube and aluminum shroud tube, and measuring the depth of wear corrosion attack, mechanical gouges, defects, etc. The monitoring schedule is based on the concept of inspecting one-half of the tubes at least twice within 14 reactor operating periods. Under this schedule, two tubes from each of three alternate sextants of the reactor are inspected at the end of each ten day reactor operating period. Repeat inspections are normally made after three and before seven consecutive operating periods. Provisions are made to inspect and tube in which a fuel element failure has occurred. To date eight inspections were made under this schedule with seven inspections made before establishment of this schedule. Visual inspections showed that wear corrosion occurs at points where the fuel bundle end brackets, fuel bundle wire wraps, and fuel rod wire wraps contact the process tube wall. Wear corrosion was observed in all tubes. Pressure tubes in which fuel elements were removed and replaced show evidence of new wear corrosion. Upper and lower fuel element end brackets produced wear corrosion in all tubes. Spiral wire wraps of individual fuel rods produced wear corrosion mainly near the ends of some fuel bundles. Spiral wire wraps of fuel bundles produced wear corrosion randomly in the tubes. This was observed in all tubes charged with fuel elements of this type. Strap or wire bands of circumferentially banded fuel bundles produced little or no wear corrosion. Measurements showed that the tube wall penetration by wear corrosion ranges from less than one mil to about 12 mils. Evidence of severe mechanical damage from fuel bundle charge-discharge operation was not observed. Inside diameter measurements showed that there was no significant creep deformation of the process tubes. There was no detectable tube diameter increase within measuring instrument accuracy (~±2 mils). This behavior was consistent with data from creep tests on sections of pressure tubes and superior to performance predicted by tensile creep data from annealed Zircaloy-2 strip. For most of the channels inspected, the measured eccentricity of the helium gas annulus separating the Zircaloy-2 pressure tube and the aluminum shroud tube, was small and well within specifications. In two channels, 1348 and 1857, the eccentricity of the helium gas annulus exceeded operating specification. (Operating specifications limit the closest approach of the Zircaloy-2 pressure tube to the aluminum shroud tube to 50 mils.) In the case of Channel 1857, this specification was exceeded twice since PRTR startup. Over-all results from the PRTR pressure tube monitoring program indicate the tubes to be performing satisfactorily on a creep strength basis. The effects of wear corrosion are being evaluated. (auth)

34113 (NP-12073) SOVIET BERYLLIUM PHYSICS REACTOR (BRF). Review of Soviet Literature. AID Work Assignment No. 16. (Library of Congress. Aerospace Information Div., Washington, D. C.). Aug. 31, 1962. 13p. (AID-Report-62-127)

A detailed description of the Soviet Be Physics Reactor is presented. The description is based on Soviet open literature. (J.R.D.)

34114 (NP-12078) SOME REPORTS ON SEMI-HOMOGENEOUS REACTOR PROJECT. (Japan Atomic Energy Research Inst., Tokyo). Feb. 1962. 201p.

The name semi-homogeneous fuel was given to a mixture of uranium oxide or carbide evenly dispersed in a matrix of graphite. A critical facility was constructed to obtain critical data and other reactor physics information on the Semi-Homogeneous Reactor. Studies were made of the fuel, reprocessing of fuel, and graphite. (M.C.G.)

34115 (ORNL-TM-351) ORR OPERATIONS FOR PERIOD APRIL 1961 TO APRIL 1962. F. T. Binford, W. R. Casto, and A. L. Colomb (Oak Ridge National Lab., Tenn.). Oct. 16, 1962. Contract [W-7405-eng-26]. 101p.

A summary of the activities in the 4th operational year is presented for the ORR. On-stream time at 30 Mw was relatively steady with 75.4 and 83.7% representing the lowest and highest quarters. Modification of the ball-latch mechanism of the shim-rod-drives is in progress. The primary cooling system bypass control valve was modified and a d-c pony motor was added at the No. 3 primary pump. This addition was made to increase the reliability of adequate water flow for afterheat cooling. A study of core-boiling detection is being conducted. (J.R.D.)

34116 (TID-16754) NORA PROJECT PROGRESS REPORT, DECEMBER 1961–JUNE 1962. (Norway. Institutt for Atomenergi, Kjeller). June 1962. Work Performed under Contract IAEA/US. 13p.

Operation of the NORA reactor is described. Experiments on the Halden II core included measurements of buckling, void coefficients, intra-cell flux, adjoint flux, and transfer functions. Measurements on the 10-cm "Savannah" lattice included: buckling, intra-cell flux, importance function, temperature coefficients, void effects in an empty lattice position, epi-thermal ratios, transfer functions, and reactor noise. A miniature facility was installed in a square vertical well in the JEEP top shielding for irradiation studies. A number of theoretical studies related to the NORA program were carried out. (M.C.G.)

34117 STATISTICAL DISPERSION OF PULSE AMPLITUDES IN THE FAST-NEUTRON BURST REACTOR. A. B. Govorkov. At. Energ. (USSR), 13: 152-4(Aug. 1962). (In Russian)

Individual fast-neutron bursts occurring with a given probability may be characterized by their energy, velocity, and spatial distributions. It is shown that the pulse amplitude dispersion may also be determined by a similar expression, which contains a factor with a value close to 1, related to the spatial neutron distribution function. Within a slight deviation, the neutron distribution at a time when the number of neutrons in the reactor is large agrees well

with the distribution calculated from its eigenfunctions. Although the individual pulse amplitudes may deviate strongly from their average value, the fluctuation stops as the pulse continues to develop. On this basis a method was derived for determining the average value of the various neutron processes. (TTT)

34118 AN ANALYSIS OF POWER EXCURSION IN TRIGA-II. Byung Ho Lee (Seoul National Univ., Korea). J. Korean Soc. Mech. Engrs., 2: 18-24(Oct. 1961). (In English)

An approximate method for analyzing a power excursion in a nuclear reactor, is proposed. The analysis is based on an equivalent model core of a reactor simplified by hot-spot-factors and consists of a nonlinear simultaneous differential equation. The original purpose is to evaluate a possible incident of maximum power excursion in TRIGA-II. In this case, the primary nuclear shutdown mechanism is solely by negative temperature coefficient, since the fuel surface temperature is below the saturation temperature of the coolant water, under the condition of the maximum of the inserted excess reactivity. Hence, the effect of the steam void generated in the water moderator or the radiolytic gas formation is ignored. Furthermore, the effect of delayed neutrons is also ignored, since the inserted excess reactivity of 2 dollars is much more than 1 dollar and emitters of delayed neutrons have much longer decay half-lives than the duration of power burst. The results agree with experiments which have been carried out in GA, so far as the inserted excess reactivities are more than 2 dollars and no formation of steam voids occurs. A phase-plane analysis of the equations representing nuclear power excursion is presented and the characteristics of inherent safety for the nuclear excursion in TRIGA-II are shown. (auth)

34119 "ANNA" THE CRITICAL ASSEMBLY OF THE SECOND POLISH EXPERIMENTAL REACTOR. Waclaw Frankowski (Inst. of Nuclear Research, Warsaw). Nukleonika, 7: 209-22(1962). (In English)

The design of the enriched uranium critical assembly with water-graphite moderator and the power order of watts are described. The assembly is being constructed as a part of a research program of the second Polish experimental high flux material testing reactor. A description of the experiment's program, parameters, and the construction of the assembly, as well as the description of main systems: control, dosimetry and so-called filling system are also given. Much attention was devoted to the problem of safety. (auth)

34120 ION EXCHANGE UNIT IN THE PRIMARY COOLING SYSTEM OF "EWA" REACTOR—CHARACTERISTICS AND OPERATIONAL DATA. Z. Bieguszewski, K. Zarnowiecki, and A. Kostyrko. Nukleonika, 7: 407-17(1962). (In Polish)

Water in the primary cooling system of the "Ewa" reactor, after not having been changed for two years, maintains high purity standards as a result of excellent performance of ionic and mechanical filters. The characteristics and analysis of physical and chemical properties of resins used in the mixed-bed deionization unit are given. Resistance of these resins to radiation from absorbed radioactive impurities is proved, and no adverse effects resulting from irradiation is observed. After regeneration, the strongly acid-strongly basic mixed-bed exchanger fully preserves its ability for complete deionization of the reactor coolant. (auth)

34121 TANK OF A SWIMMING POOL REACTOR. (to Commissariat à l'Énergie Atomique). French Patent 1,267,859. June 19, 1961.

The tank of a swimming pool reactor consists of an outer container enclosing a metallic container separated by an interspace. This interspace is filled with a pulverulent material. The outer container and the pulverulent material form an entity of which the dimensions are sufficient to ensure a suitable biological shielding. Preferably the interspace is subdivided by horizontal and vertical dividing walls into a number of cells. This interspace also encloses tunnels for ducts and circuits which are shielded by the pulverulent material which may consist of crushed heavy aggregates or sand, while the outer container consists of concrete, metal, or wood. (NPO)

SPACE APPLICATIONS AND TECHNOLOGY

Refer also to abstracts 33088, 33193, 35960, and 34093.

34122 (ASD-TR-61-315) A SOLAR THERMOELECTRIC GENERATOR SYSTEM STUDY. Joseph R. Ferrara (Hamilton Standard Div., United Aircraft Corp., Windsor Locks, Conn.). July 1, 1961. Contract AF 33(616)-7358. 266p. (AD-272152)

The results of a 2-part theoretical and practical program on a static solar thermoelectric generator are presented. The theoretical design study of a 1500-w power supply for a vehicle in a 300-mile earth oriented orbit is given. A mathematical treatment was employed for heat transfer and thermoelectric analysis, energy storage requirements, and supporting structure stress analysis. Unfolding and orientation systems are also described. The design, fabrication, and development testing of a 5-w ground model is also discussed. Manufacturing problems and their solutions are outlined, with detailed attention being given to the component parts. Data accumulated during endurance and cyclic running are presented in tabular and graphical form. (auth)

34123 (MND-1086(Del.)) RADIOISOTOPE FUELED AUXILIARY POWER UNIT. Quarterly Progress Report No. 1, January 2–April 2, 1957. Calvin C. Silverstein and Robert E. Behmer, comps. (Martin Co., Baltimore). 48p.

Progress on an isotope-fueled auxiliary power unit is reported. Based on the power requirements of 260 W, it was concluded that Ce^{144} should be used as fuel. Estimates were made of fuel availability and unit cost and weight at power levels of 133, 300, 500, and 1000 W(e). Fuel development, boiler development, system and operational considerations, and the power conservation system are discussed. (M.C.G.)

34124 (MND-2570) SURVEYOR R.T.G. DESIGN STUDY. Preliminary Report. (Martin Co. Nuclear Div., Baltimore). May 12, 1961. 97p.

The design of an isotope fueled thermoelectric generator for the Surveyor Program was evaluated in relation to the over-all spacecraft mission. Generator development, fuel development, and safety are discussed. Contractor requirements are outlined. Generator design features are described including: design, performance, materials and weight, sterilization, reliability, and fuel properties. Integration with the spacecraft is also discussed. (M.C.G.)

34125 (MND-P-2483-6) SNAP 7 PROGRAM — TASK 8—STRONTIUM-90 FUELED THERMOELECTRIC GENERATOR DEVELOPMENT. Quarterly Report No. 6, February 1 through April 30, 1962. W. A. McDonald (Martin Co. Nuclear Div., Baltimore). Contract AT(30-3)-217. 26p.

Manufacture, assembly, and parametric testing of the first 60-watt thermoelectric generator were completed. All of the Sr-90 fuel process equipment was installed. Equipment checkouts and process dry runs have indicated a number of problems. The problems will probably cause a slight delay in hot operation; however, it is expected that schedule commitments in completing the fuel for the SNAP-7B system will be met. The power output of the Coast Guard SNAP-7A system is decreasing much faster than anticipated. A comparison of power output and hot and cold junction temperature readings with parametric operational data shows that the generator is performing as predicted. A plot of the decay in hot junction temperature (cold junction temperature approximately constant) indicates that the isotope fuel had too much Sr-89 and, therefore, too little Sr-90. Restoration would consist of changing the high conducting inert gas, helium, to a mixture of helium and argon which has better thermal insulating properties. (auth)

34126 (NAA-SR-7408) APPLICATIONS OF SNAP REACTOR SYSTEMS TO COMMUNICATIONS SATELLITES. R. E. Wimmer (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 30, 1962. Contract AT(11-1)-Gen-8. 124p.

Methods are presented for determining the electric power requirements of a given communications mission in terms of mission and orbit parameters. Analyses were made of possible applications of available and projected space auxiliary power units in these satellites. The satellite as a communication node is discussed. Example calculations are given. (M.C.G.)

34127 (NAA-SR-Memo-7456) PHYSICAL ANALYSIS OF S4ER FUEL ELEMENTS. R. G. Matthews (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 11, 1962. Contract [AT-11-1-GEN-8]. 21p.

A structural analysis of the S4ER fuel element indicates that sources of stress and instability are primarily related to assembly techniques, dimensional tolerances, temperature distribution, dynamic loads, and imposed system pressure. The derivations assume an elastic, homogeneous, isotropic material without initial stress or body forces. Hence, application of the equations without cognizance of the discontinuities produced by fabrication (e.g., residual stresses) will prove inaccurate and misleading. (auth)

34128 (UCRL-6923) THE PLUTO PROGRAM. Harry L. Reynolds (California. Univ., Livermore. Lawrence Radiation Lab.). May 17, 1962. Contract W-7405-eng-48. 22p.

The Pluto Program is reviewed. Work directed toward the design of a reactor for sea-level flight of supersonic ramjet missiles is discussed. Choice of materials and reactor neutronics is considered. Design problems are outlined. The reactor concepts were developed into the Tory II-A reactor and the Tory II-C reactor. These reactors are described, and test results discussed. (M.C.G.)

34129 A MODEL FOR PLANAR ELECTRON AND ION FLUID FLOW. Roger Arnold Holmes (Purdue Univ., Lafayette, Ind.). Dissertation Abstr., 23: 576(Aug. 1962).

Space charge equations normally used in electron device design were extended to include velocity distribution effects through a pressure gradient force density in the momentum equation. The extension was made in order to have a reasonable fluid model for studies of modern devices, such as the ion rocket engine and the cesium plasma diode, for which the space charge equations alone are inadequate. The pressure model equations were solved for the planar electron diode, but the theoretical solution was phrased in terms of unmeasurable variables. The solution was then converted to measurable voltage-current characteristics of the electron diode, and the characteristics were compared with experimental curves for a lighthouse diode. The results show that the pressure model compares well with both the theoretical velocity distribution method solution and with experiment. The same model was used for a planar potassium ion diode, and again, reasonable agreement be-

tween a calculated and experimental voltage-current characteristic is obtained. A hypothesis based on reasoning from the electron pressure model is advanced to explain the electron neutralization mechanism in recent ion rocket engine experiments. A qualitative consideration of neutralization experiments showed that an accelerating electric field force density and decelerating pressure gradient force density oppose each other so that electrons are eased into the ion beam. This is in agreement with theoretical predictions based on a pressure model for the electron flow. Separate-species fluid equations, including ionization and recombination effects, were derived on a phenomenological basis.

34130 NUCLEAR-ELECTRIC SPACECRAFT CONCEPTS FOR UNMANNED PLANETARY EXPLORATION. Robert J. Beale (California Inst. of Tech., Pasadena). IRE (Inst. Radio Engrs.), Trans. Space Electron. Telemetry, SET-8: 178-82(June 1962).

The utilization of advanced, high-powered nuclear-electric spacecraft in the near future for the unmanned scientific exploration of space will provide significant weight allowances and power levels for scientific payloads and communication equipment. The electronic system designer, presently faced with minimum weight and power limitations imposed by today's chemically-propelled spacecraft, must develop new techniques to take advantage of the greater capabilities promised by nuclear-electric spacecraft. Power levels approaching 1 Mw(e) may be expected. Systems capable of employing this power must operate under an intense nuclear radiation flux at elevated temperatures for long time periods. Development of such equipment must be initiated at an early date. (auth)

34131 POTENTIALITIES OF ELECTRON BOMBARDMENT ION ENGINES FOR ELECTRIC PROPULSION. Daniel J. Kerrisk (California Inst. of Tech., Pasadena). IRE (Inst. Radio Engrs.), Trans. Space Electron. Telemetry, SET-8: 188-93(June 1962).

A discussion is given of the expected performance of electron bombardment ion sources when used for electrostatic propulsion. Two particular sources, the duoplasmatron and the Penning ion source, are examined in some detail and suggestions are made on how their performance for application with electric thrust devices could be improved. It is concluded that electron bombardment sources may offer some advantages over surface contact engines if ways can be found to significantly improve their propellant utilization. (auth)

34132 SOLAR CELLS FOR COMMUNICATION SATELLITES IN THE VAN ALLEN BELT. F. M. Smits, K. D. Smith, and W. L. Brown (Bell Telephone Labs. Inc., Murray Hill, N. J.). J. Brit. Inst. Radio Engrs., 22: 161-9(Aug. 1961).

The power output of solar cells on satellites passing through the Van Allen belt is constantly degraded due to the radiation damage. It thus becomes necessary to optimize the power output of the solar plant not initially but at a later time in the satellite life. The effect of the radiation environment on the expected life of solar cells was investigated by electron and proton bombardment studies. Based on these experiments n-on-p solar cells were specially developed for communication satellites. These cells have a moderate initial efficiency and are made very blue-sensitive, since the response to short wavelength light is considerably more resistant to radiation than the response to long wavelength light. A shielding of 0.25 g/cm^2 was found to eliminate the effect of electron irradiation with energies up to 1 Mev. Since most, if not all, electrons in the Van Allen belt have energies of less than 1 Mev, a transparent protection of moderate weight can eliminate radiation damage due to electrons. For a typical orbit passing through the inner Van Allen belt, studies under proton bombardment indicate conversion efficiencies of approximately 8% after one year and on the order of 5% after 10 years. With such conversion efficiencies, long life communication satellites appear feasible with presently available solar cells. (auth)

34133 RADIATION AND OTHER ENVIRONMENTAL EFFECTS ON SATELLITES. R. Innes (Marconi's Research Labs., Great Baddow, Essex, Eng.). J. Brit. Inst. Radio Engrs., 22: 241-50(Sept. 1961).

The radiation environments encountered by a satellite according to its orbit are summarized. The breakdown of high-energy radiation on meeting matter is described, indicating the mechanisms and nature of damage caused to equipment. An argument is presented to show that screening against hard radiation is inefficient and uneconomical. Estimates are given of the life of a transistor—the most susceptible to damage of normal electronic components—in a satellite traversing the lower Van Allen belt. Means of protection against the erosive low energy radiation are discussed and requirements to meet launching conditions are mentioned. (auth)

34134 DESIGNING FOR NUCLEAR SPACE EXPLORATION. PROBLEMS IN INSTRUMENT DESIGN. Raymond L. Heacock (California Inst. of Tech., Pasadena). Nucleonics, 20: No. 10, 55-7(Oct. 1962).

The constraints involved in the design of instruments for space exploration are reviewed. These constraints include design problems (minimum weight, telemetry, etc.), environmental problems (shock, vibration, temperature), calibration problems, and sterilization. (D.L.C.)

33135 LIFE ON MARS? Gilbert V. Levin (Resources Research Inc., Washington, D. C.) and A. Wendell Carriker. Nucleonics, 20: No. 10, 71-2(Oct. 1962).

A radiobiochemical probe, named Gulliver, probably will be included in the first capsule to be sent to Mars to detect microorganisms. When on Mars, the probe will collect samples of Martian soil, inject them into a C^{14}-tagged broth, measure the radioactivity of any evolved gas, and telemeter the data back to Earth. A culture containing an antimetabolite will be used as a control. (D.L.C.)

34136 STATIC NUCLEAR THERMOELECTRIC SYSTEM FOR SPACE. P. E. Kueser (Westinghouse Electric Corp., Lima, Ohio), P. S. Merrill, and F. G. Tauch. Preprint Paper No. 62-1436. Prepublication Copy. 10p. $1.00.

A completely static nuclear-powered thermoelectric generator is discussed. The reactor designed for SNAP-10 uses U^{235}-zirconium hydride fuel moderator and is capable of operating a thermoelectric generator at a hot side temperature of 1000 to 1200°F. A prototype thermoelectric generator is described which produced 250 watts of electric power at space operating temperatures. Waste heat radiators for the system, having constant and tapering fin thicknesses, are discussed. Curves are presented of performance versus fin number and length for both tapered and constant thickness fins. Weight and electric power capability of a present state-of-the-art thermoelectric generator-radiator system is presented in curve form and shows a 245-pound-weight for a 250 watt system exclusive of the reactor and shielding. (auth)

34137 NUCLEAR AUXILIARY POWER UNIT FOR LUNAR EXPLORATION. Robert J. Wilson, Alan J. Streb, and Thomas S. Bustard (Martin-Marietta Corp., Baltimore). Preprint No. SAE-515A. Prepublication Copy. 5p.

A radioisotope-fueled thermoelectric generator is

ideally suited to the nighttime power requirements of unmanned soft lunar landing experiments. A generator design capable of producing 25 w of electric power as well as sufficient thermal energy for environmental control of critical electronic components is described. Sufficient curium-242 may be encapsulated to provide an operational life of 90 to 120 days in a unit weighing 30 lb. This unit will extend the data gathering capability of the experiment with a significant weight advantage over conventional power supplies. (auth)

WASTE DISPOSAL AND PROCESSING

Refer also to abstracts 32885 and 32891.

34138 (HW-69263) Cs^{137} LOADING AND LEACHING OF SYNTHETIC ZEOLITE AND CLINOPTILOLITE COLUMNS. L. L. Ames, Jr. and J. L. Nelson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 12, 1961. Contract AT(45-1)-1350. 8p.

A Decalso column was loaded with synthetic 103-A tank supernatant solution spiked with 5% actual 103-A tank waste and diluted with an equal volume of distilled water. The column was washed with four volumes of tap water to simulate plant washing of the loaded zeolite and leached with several volumes of synthetic Missouri River water. This river water leaching resulted in elution of 0.63% of the Cs^{137} from the Decalso in 20 column volumes. Eventual elution of most of the Cs^{137} must be assumed in an evaluation of possible hazards under the simulated conditions. Samples of Decalso saturated with synthetic 103-A waste were fired to 1500 and 2500°F at atmospheric pressure without the formation of crystalline compounds. Leaching with several volumes of synthetic river water indicated that clinoptilolite is somewhat more resistant to elution of Cs^{137} than is Decalso. Clinoptilolite has potential for use as a Cs^{137} transportation medium. (auth)

34139 (HW-72335(Pt.1)) STEADY DARCIAN TRANSPORT OF FLUIDS IN HETEROGENEOUS PARTIALLY SATURATED POROUS MEDIA. PART 1. MATHEMATICAL AND NUMERICAL FORMULATION. R. W. Nelson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 4, 1962. Contract AT(45-1)-1350. 36p.

The equations describing macroscopically a rather general class of problems on flow in porous media are presented. The expressions extend beyond the classical saturated flow equations to include partially saturated flow in heterogeneous media and the associated reduced forms. The reduced forms include partially saturated flow in homogeneous media, saturated flow in heterogeneous media, and finally classical saturated flow in homogeneous soils. In all cases the equations were reduced to nondimensional parameters for optimum computational effectiveness. The assumptions involved in deriving the macroscopic general equations were considered in more detail than is often used. The equations presented are nonlinear and usually are complex if not impossible to solve in closed form. Accordingly, a finite difference formulation was developed preparatory to writing a rather general computer program to solve this class of problems. An iterative solution method of the Gauss-Sidel type is presented for solving the difference equation system. The several boundary condition types to be found in practical flow problems are tabulated for all combinations. An effective coding and abbreviated designation for the boundary types was prepared. The various boundary conditions peculiar to a specific flow problem can be designated rapidly from the mathematical boundary conditions through utilization of these calculation types. The computer program, which utilizes the formulation presented, exceeded the original expectations with respect to usefulness. It is possible to solve numerically steady one-dimensional, two-dimensional and axially symmetrical problems very satisfactorily. Moderate size three-dimensional problems can also be treated within size limitations imposed by the 8000 grid point capacity. Such ability in analyses may contribute appreciably to the solution of waste disposal problems through detailed study and prediction of many practical flow systems which occur in nature. (auth)

34140 (HW-SA-2726) COATING WASTE MEASUREMENT. W. H. Johnson, R. A. Schneider, and W. H. Zimmer (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [Aug. 23, 1962]. Contract AT(45-1)-1350. 13p.

Results of Hanford coating waste measurement studies are presented. The development and application of an indirect measurement method which uses a fission product, Cs^{137}, as an index of the SS material content of coating waste are described. (auth)

34141 (HW-SA-2739) ANALOG SIMULATION OF HANFORD GROUND WATER FLOW. R. W. Nelson and W. A. Haney (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 15, 1962. Contract AT(45-1)-1350. 15p.

Development of an electrical analog of the Hanford ground water flow system is described. It is noted that the independent causations which must be considered in an analysis of ground water flow include hydrodynamic dispersion, exchange reactions, and the macroscopic flow pattern. The last-mentioned causation is considered in some detail. (J.R.D.)

34142 (NAA-SR-6304) THE SNAP II POWER CONVERSION SYSTEM TOPICAL REPORT NO. 12. BOILER DEVELOPMENT. R. G. Gido, A. Koestel, H. C. Haller, D. D. Huber, and David L. Deibel (TAPCO. Div. of Thompson Ramo Wooldridge Inc., Cleveland). July 17, 1961. Contract AT(11-1)-Gen-8, Subcontract N843FS-101221. 146p. (ER-4521)

The SNAP II boilers which were designed are summarized. As shown by test results from the three boilers which were tested, a continuous progress in design was achieved. These designs were based on test data from both the SNAP I and SNAP II programs. As the quantity of data increased, physical models describing the heat transfer process were developed. These physical models provide the necessary correlation parameters which permit the extension of existing data to advanced design. Preliminary test sections were designed on the assumption that an all-vapor model which ignores the presence of the liquid phase during forced convection boiling could be used to describe the process quantitatively. The conventional Dittus-Boelter equation was applied with the increase in the vapor flow along the tube being ascribed to liquid evaporation. The assumption led to a design that fell short by about an order of magnitude since the exit qualities were only in the range of 10%, far less than required for complete vaporization. As a result, a revision in the concept of the mechanics of boiling was found necessary and a theoretical analysis was formulated, based on a "dry wall" or "dropwise" type boiling phenomenon. The test results of the preliminary test sections and the SNAP I boiler were plotted on the basis of dry-wall boiling parameters containing the area mean temperature difference and mass velocity. A conservative design curve was established and used to design the thirteen tube boiler. The design was found by test to be conservative, and the measured performance and the degree of conservatism were found to be within the expected spread in earlier test data. Dropwise boiling pictures the heat transfer as occurring directly from the wall to the

drop through a film created by the vapor being ejected from the underside of the drop. The drop is held against the wall by its inertial force induced by a swirl device. Heat transfer experiments performed with mercury droplets provided a more detailed understanding of the mechanics of dry-wall boiling. The theory thus developed compared favorably with the test data. A boiling research program was initiated to refine the design procedures presently available. In this program the detailed heat transfer data can be derived relative to a greater number of controlled variables than are attainable in prototype boiler tests. The primary efforts of the boiler development program were supplemented by other related work. These include porous bed boiler studies, mercury droplet boiling on hot plates in air, isothermal nitrogen–liquid mercury two-phase flow tests and sodium-nitrogen heat transfer tests. From these tests information was obtained on the effect of various inserts on two-phase pressure drop, the phenomena of heat transfer to drops, and the effect of primary fluid side parameters on calculation of the mercury side parameters. (auth)

34143 (ORO-580) ACCUMULATION AND CYCLING OF ORGANIC MATTER AND CHEMICAL CONSTITUENTS DURING EARLY VEGETATIONAL SUCCESSION ON A RADIOACTIVE WASTE DISPOSAL AREA. H. R. DeSelm and R. E. Shanks (Tennessee. Univ., Knoxville). [1961]. Includes Supplement: VEGETATIONAL HISTORY AND PLANT SUCCESSION ON A RADIOACTIVE WASTE AREA. Sept. 11, 1961. Contract [AT(40-1)-2077].

Studies on mineral cycling in natural vegetation, with special reference to the cycling of the products of uranium fission, were carried out over a 5-year period on the bed of White Oak Lake after it was drained in 1955. The lake had been used for several years for the impoundment of both radioactive and domestic wastes from Oak Ridge nuclear plants. A considerable body of detailed information on mineral cycling in natural vegetation was accumulated. Results are presented from studies on early succession and floristic changes on a relatively small area, and from the chemical analysis of about 40 species of plants both in terms of chemical concentration and yield on an area basis. This information is related not only to the input or accumulation portions of the cycle, but also to the accumulation and decay of litter. Major chemical elements and radioactive contaminants at trace level are considered from the standpoint of the amount of material moved per year, the proportion of material moved per year, and number of years required for return to the soil of one year's material input. The data contribute to the understanding and elucidation of the metabolism of ecosystems and provide a basis for the intelligent management of radioactive wastes. (220 references.)

34144 (EURAEC-275) RESEARCH ON THE TREATMENT OF RADIOACTIVE WASTE AND WATER. Quarterly Report No. 7, October 1, 1961–January 15, 1962. (Brussels. Centre d'Etude de l'Energie Nucleaire). Work Performed under United States–Euratom Joint Research and Development Program. Contract 048-61-4-RDB. 35p. A translation.

Tests on the uptake of evaporation and ash concentrates were made. For the former, the usual uptake technique was suitable, but for the ash, the agitator had to be replaced by a mixer. Stabilization of the asphalt-salt emulsion by the addition of colloidal slurry derived from the chemical treatment is reported along with reduction of the elution velocity of the asphalt-salt mixture by pretreating the evaporator concentrates with floculants, such as $Fe(OH)_2$ and $Ca_3(PO_4)_2$. The use of isotope solutions $K_3Co^{60}(CN)$ and $Zn^{65}(EDTA)$ as water tracers proved satisfactory in test conducted in soils. The water flow tests in the non-saturated region were continued, as well as those on the hydraulic model. Geological and hydraulic results of the 200-m deep shaft are reported. Basic research on the equilibrium of a radioisotope in a three ion macroscopic system has resulted in the drafting of formulas describing the variations of the tracer distribution in relation to the chemical composition of the medium. The chemical analyses and the physico-chemical assays on clay provide a better understanding of the ionic equilibrium, and permit an evaluation of the fixing capacities. Combustion tests provided operation information as well as ash analyses for the plant. An alteration to the post-combustion chamber reduced the amount of ash entrained by the combustion gases to about 1 kg/1000 kg of incinerated material. (auth)

34145 ATOMIC WASTE DISPOSAL. Paula Fozzy (Univ. of Chicago). Ind. Res., 4: No. 8, 27-31(Sept. 1962).

A discussion of problems of atomic waste disposal is given. The amounts of wastes will increase with time, and it is estimated that the world will have at least 1000 tons of waste to dispose of per year in the year 2000. The common methods of disposal (burial and sea storage) and their disadvantages are discussed together with suggested methods (drilling holes in ocean floor and hydraulic fracturing). Methods of solidifying wastes by calcination or vitrification are also discussed. The legal problems which would result if wastes from one country contaminated another country are emphasized. The possibility of disposing of wastes by shooting them into space with rockets is suggested, although at the present time it is not feasible. The wastes could be sent into orbit around the earth and then be recovered for processing, and the decay heat could be used to power navigational equipment. (D.L.C.)

34146 LAND BURIAL OF SOLID PACKAGED RADIOACTIVE WASTES. James M. Morgan, Jr. (Virginia Military Inst., Lexington), John C. Geyer, and David C. Costello. J. Sanit. Eng. Div., 88: No. SA3, Part 1, 139-61(May 1962).

A study was made of practices involved in land burial of solid packaged radioactive wastes in the United States. National, regional, and local burial grounds are discussed, as are source and character of wastes. Handling techniques, containers, transportation practices, and regulations are mentioned. Waste shippers and waste quantities are indicated and an estimate is made of future waste production. (Public Health Eng. Abstr., 42: No. 9, Sept. 1962)

34147 PERMANENT DISPOSAL OF LOW ACTIVITY WASTES IN CZECHOSLOVAKIA. Oldřich Žoch and Eduard Malášek. Jaderná energie, 8: 231-4(July 1962). (In Czech)

Experience gained during selection, construction, and operation of the first central storage of low activity wastes in Czechoslovakia is reported. (auth)

34148 RADIOACTIVE WASTE CONCENTRATOR. Water Waste Treat. J., 9: No. 1, 25-6(May-June 1962).

A unit known as Ray-Di-Pak combines distillation and demineralization for a reported decontamination factor of 10^6 and a distillate solids content of 2 ppm. The waste is evaporated at low temperature and high vacuum. (Public Health Eng. Abstr., 42: No. 9, Sept. 1962)

34149 ULTIMATE DISPOSAL OF HIGH LEVEL RADIOACTIVE WASTES— FIXATION IN PHOSPHATE GLASS WITH EMPHASIS ON THE CONTINUOUS MODE OF PLANT OPERATION. L. P. Hatch, G. G. Weth, and E. J. Tuthill (Brookhaven National Lab., Upton, N. Y.). Contract [AT (30-2)-Gen-16]. 19p. (BNL-6321)

To be published in proceedings of the IAEA Symposium

on Treatment and Storage of Radioactive Wastes, Vienna, Austria, Oct. 8-13, 1962.

In the study of ultimate disposal of high level radioactive wastes emphasis is being placed on the formation of phosphate glasses as a means of incorporating the fission products in stable media. Of primary interest was the development of a process in which the entire conversion from the raw aqueous wastes to the final glass product would be carried out in an all-liquid system. The phosphate glass method offers a number of important advantages in this respect and, in particular, lends itself to the development of a continuous process in which the liquid media would be readily transferable from one process step to another. The results of bench-scale studies on the production of phosphate glasses, with the continuous mode of operation, utilizing various types of aqueous wastes are presented. The studies were carried out to determine essential operating parameters with particular attention paid to corrosion resistance and physical integrity of the high temperature crucible. In addition, the flow sheet development is discussed together with the design and results of operation of an engineering-scale plant having a capacity of one cubic foot of glass per day with a continuous feed of simulated non-radioactive wastes. (auth)

CORPORATE AUTHOR INDEX

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Because of problems involving the mechanical preparation of this index, all accent marks are omitted. The following changes in spelling have been introduced to reduce some of the confusion which might result from omitting the accents:

Æ	becomes	ae
Ö		oe
ø		oe
Ü		ue (except in transliterated Chinese names)

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As an aid to the users of this index, references to report numbers, where appropriate, are included after the abstract number of the citation.

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5392	16-32908	Dep.(mc); $3.60(fs), $1.34(mf) JCL
5393	16-32909	Dep.(mc); $3.60(fs), $1.40(mf) JCL
5397	16-32955	Dep.(mc); $1.60(fs), $0.80(mf) JCL
5401	16-33164	Dep.(mc); $1.60(fs), $0.80(mf) JCL or OTS
5402	16-33165	Dep.(mc); $1.60(fs), $0.80(mf) JCL or OTS
5403	16-33166	Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS
5404	16-33279	Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS
5405	16-33435	Dep.(mc); $1.60(fs), $0.80(mf) JCL or OTS
5406	16-32626	Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS
5407	16-33167	Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS
5408	16-33436	Dep.(mc); $3.60(fs), $1.19(mf) JCL or OTS
5409	16-33437	Dep.(mc); $1.60(fs), $0.80(mf) JCL or OTS
5411	16-33168	Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS
5412	16-32956	Dep.(mc); $1.60(fs), $0.80(mf) JCL or OTS
5415	16-33169	Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS
5418	16-32694	Dep.(mc); $1.60(fs), $0.80(mf) JCL
5420	16-34081	Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS
AECL–	**(Canadian)**	
1570	16-33910	$0.50(AECL)
1586	16-32972	Can. J. Chem. 40: 1965-75(1962)
1592	16-33428	See CRGM-1103
1594	16-33583	See PR-P-54
AEET-HP–	**(Indian)**	
TM-2	16-32915	Dep.(mc)
AEEW-M–	**(British)**	
269	16-33779	Dep.; $0.35(BIS); 2s.6d.(HMSO)
AEEW-R–	**(British)**	
69	16-33971	Dep.; $0.77(BIS); 5s.6d.(HMSO)
70	16-33780	Dep.; $0.77(BIS); 5s.6d.(HMSO)
90	16-33360	Dep.; $0.98(BIS); 7s.(HMSO)
116	16-33781	Dep.; $0.42(BIS); 3s.(HMSO)
166	16-33972	Dep.; $0.70(BIS); 5s.(HMSO)
AERE-M–	**(British)**	
1064	16-33063	Dep.; $0.35(BIS); 2s.6d.(HMSO)
AERE-R–	**(British)**	
3844	16-32994	J. Less-Common Metals 4: 426-35(1962)
3925	16-32916	Dep.; $0.70(BIS); 5s.(HMSO)
3950	16-33021	Dep.; $1.12(BIS); 8s.(HMSO)
3953	16-33145	Dep.; $0.42(BIS); 3s.(HMSO)
4058	16-33592	Brit. J. Appl. Phys. 13: 508-13(1962)
4066	16-33405	p.G-5 of "Electron Microscopy. Vol. I." New York, Academic Press, 1962
4080	16-34060	Dep.; $0.70(BIS); 5s.(HMSO)
4112	16-32722	Dep.; $0.49(BIS); 3s.6d.(HMSO)
4142	16-33303	Dep.; $0.42(BIS); 3s.(HMSO)
AF-SAM–	**(Non-AEC)**	
62-67	16-32723	$5.00(fs) OTS
AFCRL–	**(Non-AEC)**	
730	16-33924	OTS
AFOSR–	**(Misc.)**	
1887*	16-33678	OTS
AFSWC-TDR–	**(Non-AEC)**	
62-15	16-33509	$1.10(fs) OTS
AID-Report–	**(Non-AEC)**	
62-127	16-34113	See NP-12073
ANL–		
6414	16-33273	Dep.; $0.75(OTS)
6556	16-33022	Dep.; $2.00(OTS)
6594	16-32949	Dep.; $0.75(OTS)
6601	16-33973	Dep.; $0.50(OTS)
6610	16-33974	Dep.; $2.00(OTS)
6619	16-33975	Dep.; $1.75(OTS)
ANL-FGF–		
342A	16-33319	See TID-16826
360	16-33465	Dep.(mc); $1.60(fs), $0.80(mf) OTS
361	16-33466	Dep.(mc); $1.60(fs), $0.80(mf) OTS
371	16-33378	See TID-16800
AP-Note–	**(Misc.)**	
398	16-34077	See TID-15256
APAE–	**(Misc.)**	
122	16-33120	Dep.(mc); $8.10(fs), $2.75(mf) OTS
APEX–		
602	16-34061	Dep.(mc); $13.50(fs), $6.08(mf) OTS
ARCRL–	**(British)**	

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7	16-33304	Dep.(mc); $0.28(BIS); 2s.0d.(HMSO)
ARF–	**(Misc.)**	
2212-6*	16-33443	$3.60(fs) OTS
2231-6*	16-33444	$1.60(fs) OTS
3187-9	16-33078	Dep.(mc); $1.10(fs), $0.80(mf) OTS
8263-2	16-33976	Dep.(mc); $5.60(fs), $2.00(mf) OTS
ARL–	**(Non-AEC)**	
62-399	16-33925	$2.60(fs) OTS
ASD-TDR–	**(Non-AEC)**	
62-348	16-33146	OTS
62-508	16-33368	$2.00(fs) OTS
ASD-TR–	**(Non-AEC)**	
61-315	16-34122	$4.00(fs) OTS
61-513(Pt.II)	16-33579	See GA-2911
61-605	16-33926	OTS
61-654	16-32917	OTS
ATL-A–		
127	16-33467	Dep.; $2.50(OTS)
BAW–	**(Misc.)**	
1202	16-34062	Dep.(mc); $10.50(fs), $4.19(mf) OTS
1244	16-33788	Dep.(mc); $9.10(fs), $3.29(mf) OTS
1259	16-33977	Dep.; $2.00(OTS)
BLG–	**(Belgian)**	
68	16-33305	Dep.(mc)
72	16-33679	Dep.(mc)
80	16-32628	Intern. J. Appl. Radiation and Isotopes 12: 64-5(1961)
81	16-33650	Phys. Status Solidi 2: 317-20(1962)
82	16-33075	Mikrochim. Acta, No. 5, 806-10(1961)
110	16-33505	Phys. Status Solidi 2: 661-7(1962)
111	16-33652	Phys. Status Solidi 2: 720-4(1962)
114	16-33054	Tetrahedron 18: 639-51(1962)
115	16-33651	Phys. Status Solidi 2: 417-20(1962)
121	16-33034	Ind. chim. belge, No. 6, 657-62(1962)
127	16-33623	Phys. Letters 1: 245-6(1962)
BMI–	**(Misc.)**	
1579	16-33445	Dep.; $1.00(OTS)
BMI-APDA–	**(Misc.)**	
660	16-33510	Dep.(mc); $9.60(fs), $3.80(mf) OTS
BMI-X–		
210	16-33369	Dep.(mc); $1.60(fs), $0.80(mf) OTS
10006	16-33370	Dep.(mc); $2.60(fs), $0.83(mf) OTS
10008	16-33978	Dep.(mc); $1.60(fs), $0.80(mf) OTS
BNL–		
752	16-33064	Dep.; $1.25(OTS)
5366	16-33789	Dep.(mc); $1.60(fs), $0.80(mf) OTS
5702	16-33964	Nuovo Cimento (10), 25: 1292-1313 (1962)
5825	16-32791	Radiation Res. 17: 492-507(1962)
5865	16-33050	Radiation Res. 17: 531-5(1962)
6056	16-33885	Phys. Rev. 127: 1680-7(1962)
6069	16-33558	p.277-98 of "Radiation Damage in Solids. Vol. I." Vienna, IAEA, 1962
6121	16-33769	Phys. Rev. 127: 2223-30(1962)
6122	16-33754	Nuovo Cimento (10), 25: 1343-55(1962)
6137	16-33900	Phys. Rev. 127: 2142-50(1962)
6144	16-32928	J. Biol. Chem. 237: 3296-8(1962)
6155	16-33406	p.G-6 of "Electron Microscopy. Vol. I." New York, Academic Press, 1962
6212	16-33912	Dep.(mc); $1.60(fs), $0.80(mf) OTS
6229	16-32724	Dep.(mc); $1.60(fs), $0.80(mf) OTS
6233	16-33680	p.233-6 of "1962 International Conference on High-Energy Physics at CERN." Geneva, European Organization for Nuclear Research, 1962
6234	16-33681	Dep.(mc); $2.60(fs), $0.92(mf) OTS
6275	16-32680	Proc. Soc. Exptl. Biol. Med. 111: 177-82(1962)
6321	16-34149	To be published in proceedings of the IAEA Symposium on Treatment and Storage of Radioactive Wastes, Vienna, Austria, Oct. 8-13, 1962.
6332	16-33682	Dep.(mc); $1.10(fs), $0.80(mf) OTS
CEA–	**(French)**	
1996	16-33782	Dep.(mc)
2135	16-33790	Dep.(mc)
2180	16-33065	Dep.(mc)
2183	16-33147	Dep.(mc)
CEA-tr–	**(French)**	
A-1032	16-32922	Dep.(mc); $3.60(fs), $1.28(mf) JCL
A-1173	16-33321	Dep.(mc); $2.60(fs), $0.89(mf) JCL
R-1522	16-33280	Dep.(mc); $4.60(fs), $1.52(mf) JCL or OTS
X-476	16-33917	Dep.(mc); $1.60(fs), $0.80(mf) JCL
CEND–	**(Misc.)**	
155	16-34063	Dep.; $1.25(OTS)
162	16-33511	Dep.; $1.75(OTS)
CISE-R–	**(Italian)**	
61	16-33980	See EURAEC-332
CNAM–	**(Turkish)**	
1	16-33987	See NP-12059
CNI–	**(Italian)**	
73	16-33306	Dep.(mc)
106	16-33307	Dep.(mc)
CDO–		
265	16-33990	See TID-7634
1019	16-33079	Dep.(mc); $4.60(fs), $1.55(mf) OTS
CRGM–	**(Canadian)**	
1103	16-33428	Dep.; $1.00(AECL)
CRRP–	**(Canadian)**	
1099	16-32918	Dep.(mc)
CUA-NE–		
16	16-32625	See NYO-9888
CVNA–	**(Misc.)**	
152	16-33512	Dep.(mc); $9.10(fs), $3.38(mf) OTS
DANATOM–	**(Danish)**	
03-62	16-34064	Dep.(mc)
DASA–	**(Misc.)**	
1264*	16-33578	OTS
1298*	16-33275	See GCA-TR-62-1-G
DC–	**(Misc.)**	
60-3-173	16-33446	Dep.(mc); $3.60(fs), $1.31(mf) OTS
DESY-A–	**(German)**	
2.94	16-33913	Dep.(mc)
DP–		
775	16-34065	Dep.; $0.75(OTS)
779	16-33429	Dep.; $0.50(OTS)
782	16-32878	Dep.; $0.50(OTS)
EDR–	**(Non-AEC)**	
2617	16-33576	See AD-273228
EFINS–	**(Misc.)**	
62-19	16-33772	Phys. Rev. 127: 2240-56(1962)
62-24	16-33709	Ann. Phys. (N.Y.) 20: 1-19(1962)
ER–	**(Misc.)**	
4521	16-34142	See NAA-SR-6304
EURAEC–		
40	16-34082	Dep.(mc); $1.60(fs), $0.80(mf) OTS
47	16-34066	Dep.(mc); $1.60(fs), $0.80(mf) OTS
223	16-33223	Dep.(mc); $1.60(fs), $0.80(mf) OTS
232	16-33459	Dep.(mc); $1.10(fs), $0.80(mf) OTS
233	16-32957	Dep.(mc); $2.60(fs), $1.07(mf) OTS
243	16-33487	Dep.(mc); $6.60(fs), $2.15(mf) OTS
275	16-34144	Dep.(mc); $3.60(fs), $1.25(mf) OTS
276	16-33979	Dep.(mc); $3.60(fs), $1.37(mf) OTS
315	16-33460	Dep.(mc); $1.10(fs), $0.80(mf) OTS
318	16-33430	Dep.(mc); $3.60(fs), $1.16(mf) OTS
323	16-33461	Dep.(mc); $4.60(fs), $1.67(mf) OTS
332	16-33980	Dep.(mc); $1.60(fs), $0.80(mf) OTS
337	16-33071	Dep.(mc); $4.60(fs), $1.46(mf) OTS
396	16-33788	See BAW-1244
403	16-33513	Dep.(mc); $1.60(fs), $0.80(mf) OTS
419	16-33162	See WCAP-2053
423	16-33978	See BMI-X-10008

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424	16-33370	See BMI-X-10006
EXP-NRX–	**(Canadian)**	
21104	16-33428	See CRGM-1103
FTD-TT–	**(Non-AEC)**	
62-1033	16-33347	OTS
FZK–	**(Non-AEC)**	
144	16-33959	
GA–	**(Misc.)**	
2512	16-33023	Dep.; $1.00(OTS)
2911*	16-33579	$2.50(fs) OTS
3015	16-33508	IAEA Preprint No. SM-26/33
3124*	16-33468	
3132	16-34067	Dep.; $2.00(OTS)
3410	16-33514	Dep.(mc); $1.10(fs), $0.80(mf) OTS
3483	16-33371	Dep.(mc); $2.60(fs), $0.98(mf) OTS
GAT-Z–		
4115	16-33447	Dep.; $1.00(OTS)
GCA-TR–	**(Non-AEC)**	
62-1-G	16-33275	
GEAP–	**(Misc.)**	
3909	16-33372	Dep.; $1.00(OTS)
3937	16-33981	Dep.; $2.00(OTS)
4032	16-33448	Dep.; $1.75(OTS)
4053-2	16-33515	Dep.(mc); $1.60(fs), $0.80(mf) OTS
GEMP–		
74	16-33982	Dep.; $1.25(OTS)
144	16-34068	Dep.(mc); $8.10(fs), $2.63(mf) OTS
HASL–		
131	16-33308	Dep.; $3.50(OTS)
HW–		
51842	16-33449	$9.10(fs), $3.26(mf) OTS
61151	16-33983	$1.60(fs), $0.80(mf) OTS
69263	16-34138	Dep.(mc); $1.10(fs), $0.80(mf) OTS
71319(Rev.)	16-33339	Dep.; $1.00(OTS)
72335(Pt.1)	16-34139	Dep.; $[illegible]75(OTS)
73318	16-33450	Dep.; $[illegible].75(OTS)
73701(Rev.)	16-34112	Dep.; $0.75(OTS)
74100	16-33361	Dep.; $1.25(OTS)
74190	16-33580	Dep.; $1.00(OTS)
74398	16-33309	Dep.; $0.75(OTS)
74429	16-33469	Dep.; $2.00(OTS)
HW-SA–		
2459	16-33410	p.G-10 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962
2496	16-33530	J. Appl. Phys. 33: 2873-5(1962)
2590	16-33310	Dep.(mc); $1.60(fs), $0.80(mf) OTS
2636	16-33066	Dep.(mc); $1.10(fs), $0.80(mf) OTS
2638	16-32725	Dep.(mc); $1.10(fs), $0.80(mf) OTS
2639	16-32950	$1.60(fs), $0.80(mf) OTS
2661	16-33442	To be published in TID-7642, Proceedings of the Symposium on Research Reactor Fuel Element, Gatlinburg, Tenn., Sept. 17-19, 1962.
2685	16-33148	$1.10(fs), $0.80(mf) OTS
2692	16-32702	Nature 196: 82-3(1962)
2693	16-32919	Dep.(mc); $4.60(fs), $1.58(mf) OTS ISA Preprint No. 60.1.62. Pittsburgh, Instrument Society of America, 1962
2702	16-33451	Dep.(mc); $1.60(fs), $0.80(mf) OTS
2723	16-33276	Dep.(mc); $2.60(fs), $0.92(mf) OTS
2726	16-34140	Dep.(mc); $1.60(fs), $0.80(mf) OTS
2731	16-32637	Dep.(mc); $1.10(fs), $0.80(mf) OTS
2739	16-34141	Dep.(mc); $1.60(fs), $0.80(mf) OTS
2740	16-33311	Dep.(mc); $1.60(fs), $0.80(mf) OTS
I–		
A2392-1	16-34071	See NYO-9786
IA–	**(Non-AEC)**	
737	16-32701	Nature 192: 1303-4(1961)
743	16-33914	Dep.(mc)
749	16-32879	Dep.(mc)
IDO–		
16758	16-33783	Dep.(mc); $4.60(fs), $1.43(mf) OTS
INSJ–	**(Japanese)**	
49	16-33149	Dep.(mc)
INTERNUC–	**(Misc.)**	
67	16-33984	$9.10(fs), $3.35(mf) OTS
IS–		
406	16-33630	Phys. Rev. 127: 1537-42(1962)
446	16-33645	Phys. Rev. 127: 2046-51(1962)
ISR–	**(Italian)**	
87	16-34002	See AEC-tr-5309
ISS–	**(Italian)**	
61/30	16-33150	Dep.(mc)
JLI–		
2748-0-5	16-33340	Dep.; $2.75(OTS)
JPRS–	**(Non-AEC)**	
14861(Excerpt)	16-32738	OTS
15018	16-32739	OTS
KFK-tr–	**(German)**	
112	16-32958	Dep.(mc); $1.60(fs), $0.80(mf) JCL
KR–	**(Norwegian)**	
24	16-32624	Dep.(mc)
26	16-33791	Dep.(mc)
LA–		
2729	16-33362	Dep.; $1.75(OTS)
LADC–		
5250	16-33647	Phys. Rev. 127: 2101-4(1962)
5275	16-33626	Phys. Rev. 127: 1441-5(1962)
5334	16-33897	Phys. Rev. 127: 2113-22(1962)
5424	16-33067	Trans. Am. Nucl. Soc. 5: 459-60(1962)
LAMS–		
2736	16-33452	Dep.; $0.50(OTS)
2753	16-33985	Dep.; $0.50(OTS)
2754	16-33927	Dep.; $0.50(OTS)
LM-TAB–	**(Non-AEC)**	
20	16-33373	
MCW–		
1475	16-32880	Dep.; $1.00(OTS)
MLM–		
1126	16-32881	Dep.; $2.60(fs), $1.01(mf) OTS
MND–	**(Misc.)**	
1086(Del.)	16-34123	Dep.(mc); $5.60(fs), $1.76(mf) OTS
2570*	16-34124	
MND-MD–		
2543	16-34069	Dep.(mc); $10.10(fs), $3.89(mf) OTS
MND-P–		
2483-6	16-34125	Dep.; $0.50(OTS)
MPR-XIII–		
7-62	16-33124	See TID-16451
MURA–	**(Misc.)**	
648	16-33683	Dep.; $2.50(OTS)
NAA-SR–		
6304	16-34142	Dep.(mc); $11.00(fs), $4.58(mf) OTS
6405	16-33068	Dep.; $0.50(OTS)
7408	16-34126	Dep.(mc); $10.10(fs), $3.92(mf) OTS
NAA-SR-Memo–		
7157	16-33121	Dep.(mc); $2.60(fs), $0.90(mf) OTS
7283	16-33453	Dep.(mc); $2.60(fs), $0.92(mf) OTS
7393	16-33122	Dep.(mc); $1.60(fs), $0.80(mf) OTS
7415	16-34070	Dep.(mc); $1.60(fs), $0.80(mf) OTS
7417	16-33123	Dep.(mc); $1.60(fs), $0.80(mf) OTS
7428	16-33516	Dep.(mc); $1.60(fs), $0.80(mf) OTS
7456	16-34127	Dep.(mc); $2.60(fs), $0.83(mf) OTS
7497	16-32951	Dep.(mc); $1.60(fs), $0.80(mf) OTS
7598	16-33151	Dep.(mc); $1.10(fs), $0.80(mf) OTS
NASA (Non-AEC)		
N62-16103	16-33659	See NASA-TN-D-1474
NASA-TN–	**(Misc.)**	
D-1405*	16-33581	
D-1453*	16-33363	OTS
D-1460*	16-33986	$0.75(OTS)
D-1474*	16-33659	$1.75(fs) OTS

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NAI–	**(Misc.)**	
7218-1	16-33454	Dep.(mc); $3.60(fs), $1.40(mf) OTS
7253	16-33477	Dep.(mc); $2.60(fs), $0.89(mf) OTS
NP–	**(AEC File No. for Non-AEC Reports)**	
12059	16-33987	Dep.(mc)
12068	16-33312	
12069	16-33313	
12073	16-34113	$1.60(fs) OTS
12078	16-34114	Dep.(mc)
12083	16-33374	
12084	16-33341	
12086	16-33342	
12089	16-32726	$1.10(fs) OTS
12090	16-33928	
12091	16-33343	$1.10(fs) OTS
12093	16-33344	
12094	16-33152	Dep.(mc)
12095	16-33345	
12097	16-33455	
12119	16-33456	
12125	16-33080	Dep.(mc)
12127	16-32727	
12131	16-33929	$3.60(fs) OTS
12132	16-33346	
12134	16-33684	Dep.
12135	16-33685	Dep.
NP-tr–	**(AEC File No. for Non-AEC Translations)**	
920	16-33170	Dep.(mc); $5.60(fs), $2.00(mf) JCL
921	16-33348	$2.60(fs), $0.89(mf) JCL
922	16-32959	Dep.(mc); $1.60(fs), $0.80(mf) JCL
NRC–	**(Canadian)**	
6931	16-32971	Can. J. Chem. 40: 1943-50(1962)
NRL–	**(Misc.)**	
5630*	16-33988	$2.75(OTS)
5828*	16-33582	$1.60(fs) OTS
NYO–		
2997	16-33511	See CEND-162
9786	16-34071	Dep.(mc); $15.50(fs), $7.37(mf) OTS
9888	16-32625	Dep.(mc); $10.50(fs), $4.16(mf) OTS
10135	16-33768	Phys. Rev. 127: 2206-18(1962)
10171	16-32920	Dep.(mc); $1.60(fs), $0.80(mf) OTS
10244	16-33686	Dep.(mc); $9.10(fs), $3.26(mf) OTS
10444	16-33517	Dep.(mc); $2.60(fs), $1.01(mf) OTS
10469	16-33375	Dep.(mc); $2.60(fs), $0.89(mf) OTS
OAK–		
28	16-[illegible]78	See TID-16697
ORA–	**(Misc.)**	
04526-4P*	16-33119	See AD-275147
ORNL–		
1227	16-34072	Dep.(mc); $14.00(fs), $6.41(mf) OTS
1294	16-34073	Dep.(mc); $13.00(fs), $5.90(mf) OTS
2106(Pts.1-5)	16-34074	Dep.; $18.00(fs), $8.75(mf) OTS
3298	16-33069	Dep.; $0.50(OTS)
3314	16-32882	Dep.; $3.50(OTS)
3323	16-32952	Dep.; $1.00(OTS)
ORNL-TM–		
78	16-34075	Dep.(mc); $7.60(fs), $2.39(mf) OTS
292	16-32905	Dep.(mc); $5.60(fs), $1.82(mf) OTS
297	16-33070	Dep.(mc); $4.60(fs), $1.58(mf) OTS
311	16-33518	Dep.(mc); $2.60(fs), $0.98(mf) OTS
317	16-33519	Dep.(mc); $2.60(fs), $0.89(mf) OTS
338	16-33376	Dep.(mc); $1.60(fs), $0.80(mf) OTS
351	16-34115	Dep.(mc); $9.10(fs), $3.73(mf) OTS
383	16-33792	Dep.(mc); $1.60(fs), $0.80(mf) OTS
ORO–		
547	16-33549	p.43-63 of "Radiation Damage in Solids. Vol. I." Vienna, IAEA, 1962
580	16-34143	Dep.; $2.25(OTS)
583	16-32638	Dep.(mc); $8.10(fs), $2.63(mf) OTS
PAN–	**(Polish)**	
309/XVII	16-33520	Dep.
312/VIII	16-32921	Dep.
319/I-B	16-33377	Dep.
322/I-B	16-33521	Dep.
324/I-A	16-33153	Dep.
325/VII	16-33793	Dep.
326/VI	16-33687	Dep.
327/VI	16-33688	Dep.
328/VI	16-33689	Dep.
329/XVII	16-33690	Nukleonika 7: 379-88(1962)
332/XIII	16-33357	Dep.
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867,127	16-33107	
1,204,590	16-34106	
1,213,459	16-33108	
1,226,419	16-34107	
1,235,551	16-33109	
1,239,164	16-34099	
1,239,202	16-34015	
1,242,466	16-33110	
1,242,701	16-34016	
1,243,732	16-34100	
1,244,114	16-34017	
1,246,060	16-32948	
1,246,587	16-33139	
1,247,091	16-34018	
1,247,832	16-34019	
1,248,538	16-34020	
1,248,876	16-33111	
1,248,919	16-34101	
1,248,934	16-33264	
1,249,341	16-33112	
1,250,963	16-34021	
1,251,489	16-34102	
1,251,823	16-34022	
1,252,670	16-34023	
1,255,862	16-34024	
1,256,113	16-33265	
1,256,114	16-34025	
1,256,186	16-34026	
1,259,177	16-34027	
1,259,242	16-33266	
1,259,687	16-33267	
1,259,728	16-33268	
1,260,312	16-33113	
1,261,010	16-34028	
1,261,067	16-34029	
1,261,191	16-34030	
1,261,620	16-33269	
1,261,628	16-33270	
1,261,629	16-33271	
1,261,673	16-34031	
1,262,799	16-34032	
1,263,383	16-33140	
1,263,441	16-34033	
1,263,532	16-33114	
1,263,814	16-34034	
1,264,273	16-34035	
1,264,420	16-34036	
1,264,648	16-33141	
1,265,483	16-34103	
1,265,778	16-34104	
1,266,003	16-33115	
1,266,010	16-34037	
1,266,813	16-32688	
1,267,859	16-34121	
1,267,956	16-34038	
1,268,244	16-34039	
1,268,775	16-34040	
1,268,807	16-34041	
1,268,929	16-34042	
1,269,100	16-33116	

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1,269,168	16-33272	
1,269,566	16-34043	
1,269,659	16-34044	
1,269,965	16-34045	
1,270,023	16-34105	
1,270,133	16-33142	
1,270.728	16-34046	
1,270,970	16-33117	
1,271,538	16-34047	
1,272,066	16-34048	
1,272,893	16-34049	
1,272,954	16-34050	
1,273,227	16-34051	
1,273,312	16-34052	
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3,059,688	16-33464	
3,059,908	16-33143	
3,060,108	16-34058	
3,060,111	16-34059	
PPAD–		
464D	16-33915	Dep.(mc); $2.60(fs), $1.10(mf) OTS
PR-P–	**(Canadian)**	
54	16-33583	Dep.; $2.00(AECL)
PUC–		
1962-60	16-33893	Phys. Rev. 127: 1739-45(1962)
1962-63	16-33902	Phys. Rev. 127: 2159-79(1962)
PWAC–	**(Misc.)**	
376	16-32953	Dep.; $0.75(OTS)
R–	**(Misc.)**	
62SD8*	16-33930	$3.60(fs) OTS
RED-EPM–		
94	16-33991	See TID-16733
REIC–	**(Non-AEC)**	
24	16-33522	$8.60(fs) OTS
RME–		
4539(Rev.)	16-33277	Dep.; $0.75(OTS)
SC–	**(Misc.)**	
4642(RR)	16-33478	Dep.; $1.25(OTS)
4689(RR)	16-33314	Dep.; $1.25(OTS)
SCDC–		
2847	16-33479	See TID-16734
SL–	**(Misc.)**	
1949	16-34076	Dep.; $2.25(OTS)
SRO–		
72	16-33989	Dep.(mc); $1.60(fs), $0.80(mf) OTS
STI-PUB–	**(International**	**Atomic Energy Agency)**
20(Vol.I(p.117-22))	16-33279	See AEC-tr-5404
36(p.409-14)	16-33703	See AEC-tr-5232
42(Vol.I(p.127-30))	16-33169	See AEC-tr-5415
42(Vol.I(p.131-8))	16-33164	See AEC-tr-5401
42(Vol.I(p.313-20))	16-33165	See AEC-tr-5402
42(Vol.II(p.121-5))	16-33168	See AEC-tr-5411
42(Vol.II(p.215-19))	16-33167	See AEC-tr-5407
42(Vol.II(p.369-77))	16-33166	See AEC-tr-5403
42(Vol.III)	16-33221	$11.00(IAEA)
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56(Vol.II)	16-33564	$6.00; 126s.; NF 24; DM 21(IAEA)
TID–		

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14165	16-33570	p.191-203 of "Radiation Damage in Solids, Vol. II." Vienna, IAEA, 1962
15037	16-34008	Nukleonik 4: 200-8(1962)
15185	16-32993	J. Less-Common Metals 4: 419-25(1962)
15256	16-34077	Dep.(mc); $15.00(fs), $7.07(mf) OTS
15322	16-32797	Radiation Res. 17: 573-8(1962)
15456	16-33535	J. Appl. Phys. 33: 3108-18(1962)
15736	16-33474	See HW-74429(p.45-58)
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15809	16-33767	Phys. Rev. 127: 2123-33(1962)
15821	16-33586	Ann. Phys. (N. Y.) 20: 61-77(1962)
15838	16-33770	Phys. Rev. 127: 2231-5(1962)
15897	16-33643	Phys. Rev. 127: 1969-79(1962)
16451	16-33124	Dep.(mc); $2.60(fs), $0.86(mf) OTS
16458	16-32689	Dep.(mc); $10.50(fs), $4.37(mf) OTS
16459	16-32639	Dep.(mc); $6.60(fs), $2.06(mf) OTS
16625	16-33691	Dep.(mc); $1.10(fs), $0.80(mf) OTS
16635	16-32690	Dep.(mc); $1.60(fs), $0.80(mf) OTS
16678	16-33154	Dep.(mc); $1.10(fs), $0.80(mf) OTS
16687	16-33692	Dep.(mc); $1.10(fs), $0.80(mf) OTS
16694	16-33523	Dep.(mc); $2.60(fs), $0.83(mf) OTS
16697	16-34078	Dep.(mc); $3.60(fs), $1.22(mf) OTS
16698	16-33081	Dep.(mc); $1.60(fs), $0.80(mf) OTS
16718	16-33584	Dep.(mc); $8.10(fs), $2.63(mf) OTS
16725	16-33693	Dep.(mc); $4.60(fs), $1.55(mf) OTS
16727	16-33694	Dep.(mc); $1.10(fs), $0.80(mf) OTS
16732	16-32728	Dep.(mc); $2.60(fs), $0.92(mf) OTS
16733	16-33991	Dep.(mc); $1.60(fs), $0.80(mf) OTS
16734	16-33479	$12.00(fs), $5.12(mf) OTS
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16741	16-33315	Dep.(mc); $1.10(fs), $0.80(mf) OTS
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16746	16-33696	Dep.(mc); $1.10(fs), $0.80(mf) OTS
16748	16-33794	Dep.(mc); $1.10(fs), $0.80(mf) OTS
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16769	16-33316	Dep.(mc); $1.60(fs), $0.80(mf) OTS
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16776	16-32732	Dep.(mc); $1.60(fs), $0.80(mf) OTS
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16829	16-33156	Dep.(mc); $1.60(fs), $0.80(mf) OTS
16833	16-33431	Dep.(mc); $4.60(fs), $1.46(mf) OTS
16835	16-32693	Dep.(mc); $1.60(fs), $0.80(mf) OTS
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UAC–		
6166	16-33886	Phys. Rev. 127: 1687-90(1962)
6499	16-32730	See TID-16742
6503	16-33991	See TID-16733
6505	16-33694	See TID-16727
6507	16-33692	See TID-16687
6519	16-33697	See TID-16749

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6521	16-33794	See TID-16748
6524	16-33696	See TID-16746
6540	16-33695	See TID-16745
6543	16-32728	See TID-16732
6566	16-32729	See TID-16735
6577	16-33466	See ANL-FGF-361
6590	16-32731	See TID-16763
6604	16-32734	See TID-16977
6634	16-33465	See ANL-FGF-360
6669	16-33319	See TID-16826
6670	16-33378	See TID-16800
6673	16-33156	See TID-16829
6674	16-32692	See TID-16796
6682	16-33992	See TID-16805
IAG-R-	**(Non-AEC)**	
112	16-33278	
UCRL-		
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6700	16-33931	Dep.; $2.75(OTS)
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6725	16-33457	Dep.(mc); $3.60(fs), $1.13(mf) OTS
6831	16-33898	Phys. Rev. 127: 2134-7(1962)
6896	16-33415	p.H-4 of "Electron Microscopy. Vol. 1." New York, Academic Press, 1962
6923	16-34128	Dep.; $0.75(OTS)
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7071	16-33157	Dep.(mc); $2.60(fs), $1.04(mf) OTS
9958	16-32649	See UCRL-10211(p.89-91)
10010	16-33947	J. Appl. Phys. 33: 2714-15(1962)
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10089	16-33748	Nuovo cimento (10), 25: 923-30(1962)
10132	16-33916	Dep.; $0.50(OTS)
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10211(p.117-21)	16-32652	Nature, 196: 279-80, 1962
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5033	16-33483	Dep.(mc); $2.60(fs), $0.86(mf) OTS
UR-		
615	16-32736	Dep.; $4.60(fs), $1.46(mf) OTS
USNRDL-TR-	**(Non-AEC)**	
574	16-33161	$1.60(fs)
579	16-32737	$5.60(fs)
UT-ARL-		
1	16-32638	See ORO-583
VDIT-	**(Swedish)**	
61	16-33127	Dep.(mc)
WADD-TN-	**(Non-AEC)**	
61-18(Pt.II)	16-33484	$2.75(fs) OTS
WADD-TR-	**(Non-AEC)**	
61-123(Pt.II)	16-33432	$2.75(fs) OTS
WAL-	**(Non-AEC)**	
372/32-1	16-33458	$4.60(fs) OTS
WAPD-	**(Misc.)**	
260	16-34079	Dep.; $2.50(OTS)
263	16-33524	Dep.; $3.50(OTS)
WAPD-BT-		
26	16-33993	Dep.; $2.25(OTS)
WAPD-DLE-	**(Non-AEC)**	
319	16-33485	Dep.(mc); $2.60(fs), $0.98(mf) OTS
WAPD-MRP-		
99	16-34080	Dep.; $2.50(OTS)
WAPD-T-		
1439	16-33994	See WAPD-BT-26(p.1-8)
WAPD-TM-	**(Misc.)**	
307	16-33433	Dep.; $1.00(OTS)
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2053	16-33162	Dep.(mc); $1.60(fs), $0.80(mf) OTS
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9	16-33979	See EURAEC-276
Y-		
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